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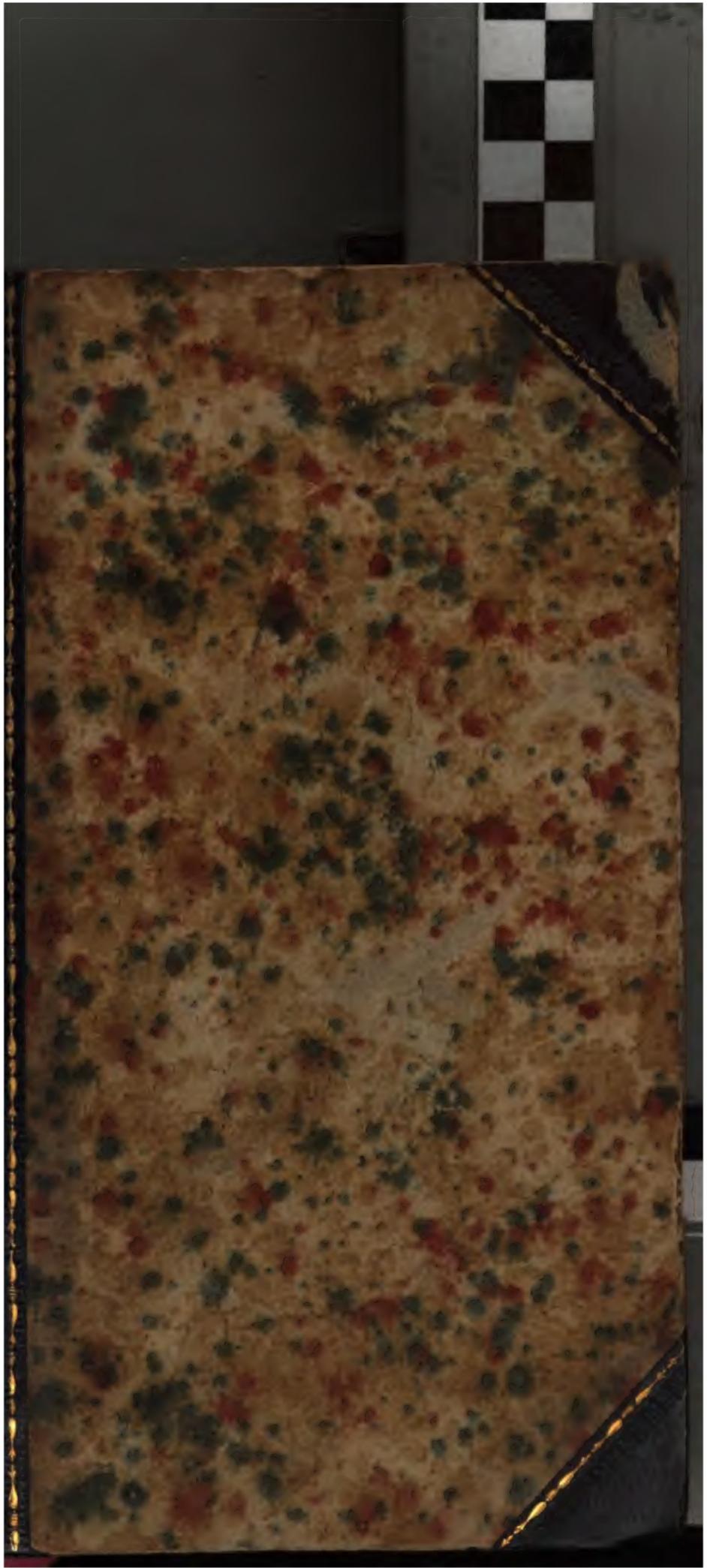
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HENRY COLLINGWOOD.



Br. from W.H. Robinson



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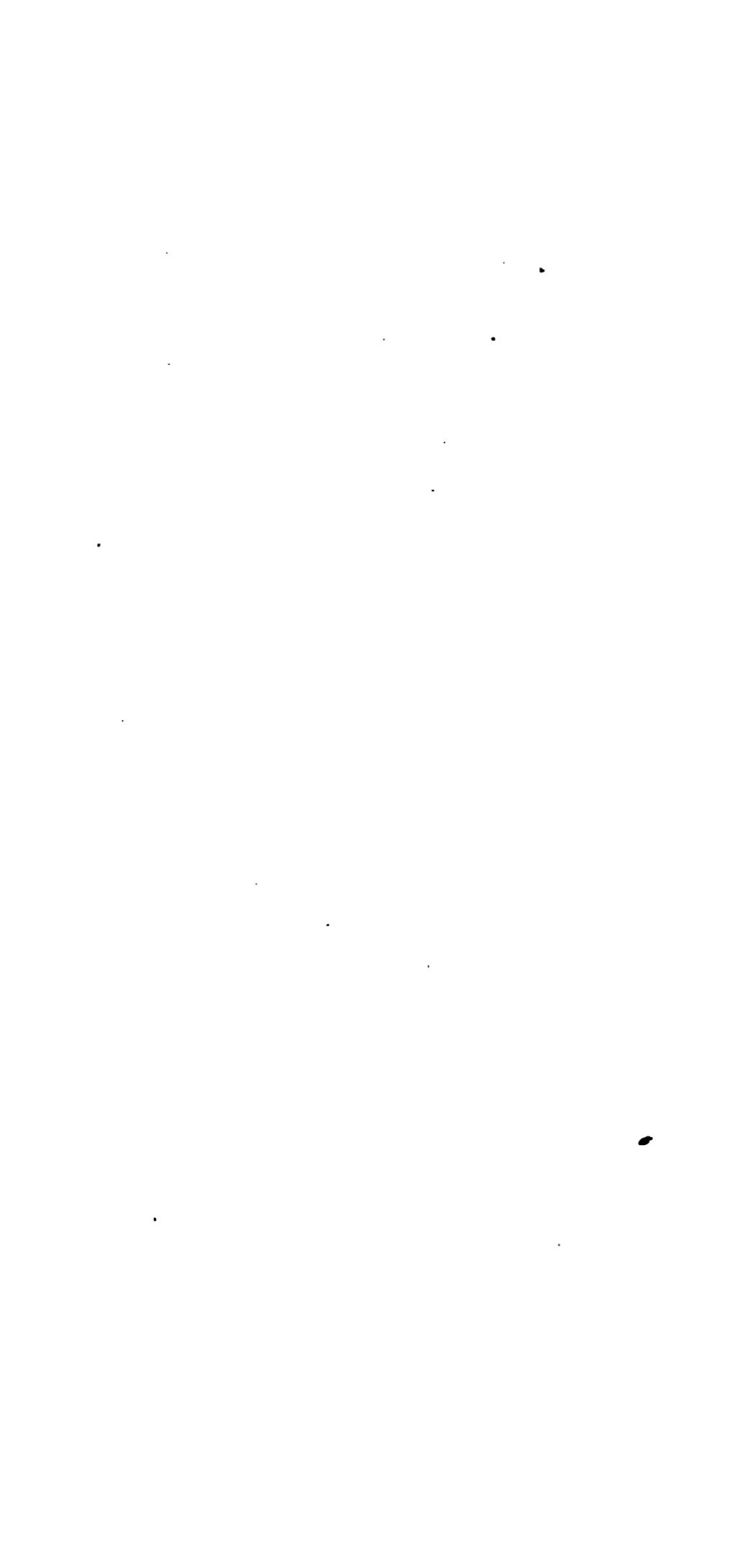








THE
PRINCIPLES AND PRACTICE
OF
AGRICULTURE,
&c. &c.





SEED-TIME.

THE
PRINCIPLES AND PRACTICE
OF
AGRICULTURE,
SYSTEMATICALLY EXPLAINED;
IN TWO VOLUMES:

Being a Treatise compiled for the Fourth Edition of
The ENCYCLOPÆDIA BRITANNICA,

AND REVISED AND ENLARGED BY
ROBERT FORSYTH, Esq.

VOL. I.

EDINBURGH:

PRINTED BY THE PROPRIETOR, A. BELL.
AND SOLD BY ARCH. CONSTABLE & CO. EDINBURGH;
AND VERNOR & HOOD, LONDON.

1804.



TO
THE RIGHT HONOURABLE
LORD SHEFFIELD,
PRESIDENT,
AND THE OTHER MEMBERS
OF
THE BOARD OF AGRICULTURE,

THIS WORK IS RESPECTFULLY DEDICATED,

BY
THE PROPRIETOR.

P R E F A C E.

IT may here seem necessary to give some account of the origin and progress of the work now presented to the public.

In the third edition of the *Encyclopædia Britannica*, which has been received by the world with such approbation, as to obtain a degree of currency, which is without example in works of such magnitude, the art of Agriculture was discussed under the various separate heads, of Agriculture, Husbandry, Draining, Mofs, and others, suggested by the alphabetical arrangement of a dictionary of Arts and Sciences. The property of that work having at length become concentrated in an individual, he resolved to proceed to a fourth edition, containing such alterations and improvements, as the course of time and the progress of the arts had rendered necessary.

In the execution of this task, it appeared an object of importance, to concentrate, as much as possible, the discussion of the various branches of Science or of Art, into a systematic form, under a few distinct heads; instead of leaving their different parts and members scattered, as formerly, throughout eighteen or twenty volumes.

Accordingly, at the commencement of the fourth edition of the *Encyclopædia Britannica*, the proposed alteration was undertaken with regard to the subject of Agriculture, which, from the alphabetical arrangement, necessarily presented itself for discussion at a very early period of the work. The various branches of that art were condensed into a single treatise; and, although

although various particulars were introduced or discussed at greater length than formerly, yet by lopping off the redundancies which unavoidably occurred in the former scattered mode of discussion, and by adhering strictly to a systematic arrangement, the whole was considerably abbreviated.

After the treatise alluded to had been compiled and printed, it occurred to the proprietor, that considerable numbers of persons, to whom the perusal of it might be productive of much advantage, would be very unlikely to become purchasers of a literary work of such magnitude and expence as the Encyclopædia Britannica. As it is of the utmost importance, however, to the public, to give all possible currency to literary works upon an art which is of such extensive and essential utility to mankind, a resolution was adopted to introduce to the world, as a separate publication, the treatise upon Agriculture, which had been prepared for the fourth edition of the great work above mentioned. At the same time it was thought, that before carrying this resolution into effect, it might be proper to revise the whole treatise, and to make such additions or alterations as should seem requisite for its farther improvement. This task has accordingly been undertaken, and the result is presented to the public. The alterations which have been made considerably exceed, both in number and extent, what was originally intended; so that a great part of the treatise has changed its character, although the former arrangement has, upon the whole, been adhered to: In particular, the history of the art has been much enlarged; advantage has been taken of recent publications, especially of those which the Board of Agriculture suggested or brought forward, to explain the principles

principles upon which the rotation of crops and the culture of graftes ought to be conducted; various other branches of the subject have, in like manner, been enlarged or altered; and some subjects of agricultural curiosity in the practice of foreign nations have been introduced, which, it is hoped, will prove not unacceptable to the class of readers for whose use this work is intended.

Throughout the treatise, practical utility is the object kept in view; and the notions of ingenious and speculative men, which have a tendency to mislead into rash projects persons engaged or engaging in agriculture, are carefully avoided. No more of theory is introduced than seemed absolutely necessary to exhibit a view of those general principles, which long experience in the art has dictated to men of sound judgment and correct observation.

In the details given, conciseness, as far as consistent with perspicuity, has been chiefly kept in view; but by adhering strictly to a systematic arrangement, a very great variety of subjects will be found introduced and discussed.

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TO THE BINDER.

**A Vignette of Harvest, and the Plates N° VII. X. XII.
XIV. and XX. to be inserted in Vol. II.: the re-
mainder in Vol. I.**

A
SYSTEM
or
AGRICULTURE.

INTRODUCTION.

AGRICULTURE in general, or in the abstract, Definition. may be defined to be, The art of making the earth to produce in large quantities, and in the greatest perfection of which their nature is capable, those vegetables which are necessary to the subsistence, or useful for the accommodation, of mankind. Agricul- Differ from gardening. ture differs from gardening in this respect, that the gardener is chiefly occupied in rearing small quantities of the nicer and more delicate vegetables, which are rather valued as objects of luxury than as articles of food; whereas the agriculturist labours upon a larger scale, with a view to supply himself and his countrymen with the necessaries of life.

In civilized societies, agriculture, or the cultivation Is a separate art. of the soil, becomes a separate business or employment; and agriculturists, or the persons engaged in agriculture, receive the appellation of *farmers* or *husbandmen*.

To enable the agriculturist or husbandman to conduct his business with success, it is necessary that he Includes the rearing of cattle. should

Nature of ^{the Art.} should not confine his attention to the mere cultivation of the soil, or the rearing of vegetables. The vegetables which are capable of affording a comfortable subsistence to the human constitution are few in number; and it has been found by experience, that they cannot be profitably sown and reproduced year after year upon the same spot of ground. Hence it becomes necessary at times to rear upon it grasses or other plants which are unfit for affording nourishment to man. But although men cannot eat grass, they may, nevertheless, contrive to obtain subsistence from it in an indirect manner. They may give it to cattle, whose ordinary and natural food it is; and having thus, as it were, converted the grass into the flesh of animals, they can devour these animals; and in this way, obtain a richer and more stimulating food than any vegetable production can possibly afford. It is therefore a part of the business of the husbandman to rear and to feed those animals which are used as food in the society of which he is a member, that he may be enabled at all times to derive profit from the portion of territory that he cultivates. It is also necessary towards conducting his operations with success, that he should rear and feed other animals, not as a source of human subsistence, but for the sake of the services which they are capable of affording; for it has pleased the beneficent Contriver of this world, to place upon it beings of a subordinate nature, capable of assisting mankind in their labours, without being degraded by the state of servitude in which they are placed. To the cultivators of the soil, these animals, from their strength and patience of labour, are particularly useful, and even absolutely necessary in our cold and barren climates.

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mates. They must therefore be fed and lodged with <sup>Importance
of the Art.</sup> the greatest care.

Hence, the employment of the husbandman is of an extensive nature, requiring much foresight, and a considerable knowledge of the relations that subsist between the most important objects in nature—the soil, the seasons, the animals, and the plants, so far as they are connected with the subsistence of mankind. It is by bringing to perfection this art that man becomes truly the lord of the universe. He subdues by his operations every part of the surface of the earth, and acquires over the animals which inhabit it, a solid right of dominion or of property, in consequence of having reared, and afforded them subsistence by his skill and his labour. He uses them indeed as food; but before he can do so, he must first bestow upon them subsistence, attend to their multiplication, and to their health and welfare. As they possess no foresight, the purpose to which they are destined is to them no evil.

It is only in proportion to the degree in which this important art of agriculture has flourished, that nations have been, or ever can be, permanently prosperous. Every improvement that is made in it is a moral benefit conferred upon mankind; for, by increasing the quantity of human food, or facilitating the production of it, one of two things must always happen: Either the number of our species will be increased, that is to say, a greater multitude of rational and intelligent beings will exist in the creation; or a greater number of those who already exist, will find leisure for the improvement of their intellectual characters, by studying and carrying to perfection the sciences and arts. Thus, the

History. strength of nations is increased in proportion to the degree in which their soil is skilfully cultivated, and their independence is secured by finding upon the spot which they inhabit all that is necessary for their subsistence.

Its advantages to those who practise it.

It is a fortunate circumstance, that the art of the husbandman, which is the foundation of all others, and at all times indispensable to human existence, is in every respect conducive to the welfare of those engaged in it. The practice of it bestows health upon the body ; and by the variety of occupations which it affords, it also bestows a considerable degree of reflection upon the minds of the lowest persons occupied in it ; while, at the same time, it prevents their acquiring that spirit of artifice and of cunning, which in all countries is apt to degrade the character of those engaged in the inferior branches of commercial employment. Nor does it fail, in all ranks and conditions of life, to produce a more candid and liberal character than any other employment. No British husbandman has ever refused, or even hesitated to allow to be communicated to the public every branch of his art, and every improvement which he and his forefathers may have made in it ; whereas, in all the branches of manufacture or of commerce, every transaction, as far as possible, is covered with a mysterious veil of secrecy, and every improvement is concealed by its inventor, and sometimes undoubtedly perishes with him.

History.

No branch of history is more instructive, nor consequently more important, than that which explains the progress of the human mind in the discovery and improvement of the useful arts. As the art of agriculture, in point of utility, ranks above all others, a detail of the efforts

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efforts by which ingenious men have brought it to its History. present degree of perfection, would undoubtedly prove extremely interesting. It has hitherto, however, been one of the misfortunes of mankind, that, in consequence of a false taste, they have bestowed more attention and applause upon great talents or ingenuity, when exerted in the arts of destruction, than when employed in devising the means of giving plenty and felicity to nations. The writings of historians and poets are filled with the actions of men, who, under the influence of an insatiable lust of dominion, have wasted cities and provinces, and have defaced the fairest monuments of human genius and industry; while the beneficent enterprizes and efforts of those men are neglected or forgotten, who invented the instruments of agriculture, who selected or imported into their country the plants most worthy of cultivation, or who drained morasses, gave fertility to barren wastes, and pointed out the best modes of preserving and augmenting the productive powers of the soil.

Mankind have suffered severely, in consequence of their absurd admiration of successful ambition, and the applause which they bestow upon it. By this applause they in every age tempt restless individuals to lay schemes for their destruction, and to glory in the debasement and misery which they bring upon large portions of the human race. It were well, therefore, if the friends of humanity could contrive to do away this false taste, by calling from obscurity, and bestowing a just portion of renown, upon the true friends of mankind, whose labours have in ancient or modern times been directed towards promoting the best interests of mankind by the improvement of this most important

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History. of all arts. The materials, however, for a history of agriculture are few, and it is inconsistent with our plan to give more than the most general outline of what is known concerning it in past ages.

The history of agriculture is equivalent to the history of civilization and of arts. Men who pass their days in the unsettled state of hunters and shepherds, must always be few in number. As their wants are not many, their means of supplying them, that is, their arts, will be proportionably unimportant. It is only when the increase of their numbers has compelled them to have recourse to the cultivation of particular plants, and when the result of an improved agriculture has in its turn provided subsistence for multitudes of men in a stationary or settled state, that human ingenuity is roused to the discovery of the secrets of nature, by searching after modes of gratifying new and more refined wants than were formerly known. Accordingly, we find in every country, and in every age of the history of mankind, that agriculture has been the basis of civilization, and that they have gone hand in hand in improvement.

Eastern agriculture. The great civilized nations which in ancient times occupied the east were chiefly three: towards the rising sun was the great empire of China; on the south was India; and on the west was Persia, which in its progress still further westward, came to include the country of the Assyrians, and the territories which bound the eastern shores of the Mediterranean sea, Lesser Asia, Syria, and Egypt. In all these countries letters and arts have existed from very remote periods, and along with them, as their foundation and support, agriculture has flourished; and, which is of more importance,

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portance, the persons engaged in it have been held in very great estimation. On the contrary, the Tartars, who have in all ages occupied the northern regions of Asia, together with the great, elevated, and desert tract of country between Persia and China, have always existed in a pastoral, and consequently in a barbarous state, equally strangers to agriculture and to the arts which it produces.

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The civilization of the Chinese empire appears to have existed from the remotest antiquity; and long experience has taught that people the great importance of agriculture, and the estimation in which it ought to be held. Accordingly, by a fundamental part of their policy, it is distinguished and encouraged by the government beyond all other arts or employments. To render it honourable, the emperor annually, at the beginning of the spring, which is the commencement of their year, goes to a field in person, in a common cart or waggon, painted green, and in presence of the princes of the blood royal, of the officers of state, and first mandarins of the empire, holds the plough for a time. The ceremony is extremely solemn, and the emperor offers up prayers for a plentiful crop to his people. On the same day, a similar ceremony is performed by the governor or chief mandarin in every province of that great empire.

With a similar view of rendering it honourable, and calling the attention of all orders of men to the importance and value of agriculture, it was a custom among the ancient Persians, that once a-month their king sat down to table with a party of practical husbandmen, or persons engaged in the ordinary labours of agriculture. This people had a regular priesthood for in-

History. Structuring the people in their religious duties; and it is not a little remarkable that agriculture was represented by them as the most acceptable service which a devotee could perform in the sight of their supreme deity, the sun or element of fire. The *saint* among them was obliged to work out his salvation by the practice of all the labours of agriculture; and it was a maxim, that he who cultivates and sows the ground with care and diligence, acquires a greater chance of paradise than he could have gained by the repetition of ten thousand prayers.

Hindostan, at the time of its invasion by Alexander of Macedon, appears to have been nearly in the same state in which we at present find it. Agriculture was carefully attended to, and along with it the useful arts flourished, riches abounded, and the people were numerous, humane, and happy, though unfortunately enfeebled by a degrading superstition, which by preventing the free exertion of their faculties, renders them an easy prey to every invader. Even in their superstition, however, their respect for agriculture appears. Hence arose the divine honours long paid by them to Bacchus, as the first teacher of the art of cultivating the vine.

From a similarity of superstitions and of manners, it appears extremely probable that some close connexion subsisted at a remote period between the Hindoos and the ancient Egyptians. The banks of the Ganges and of the Nile are fertilized in the same manner, and upon both, the art of agriculture is of an extremely remote antiquity. The ancient Egyptians, like the Hindoos, raised vast quantities of corn; and so sensible were they of the importance of the art which enabled them to do so, that they

they worshipped as a god, its real or reputed inventor, History. under the appellation of Osiris. They regarded Isis, their second deity, as the discoverer of the use of wheat and barley, and as the first who, having gathered the seeds of these grains in the woods, sowed them on prepared land, and reaped a crop thus procured by art.

In these eastern nations the most valuable practices in agriculture were well known. The use of the plough was known. Hollow draining was so well understood, together with the purposes to which it may be applied, that the modern Persians are in some places said to find water in their fields, conveyed in channels, of which they know not the course, but which have been placed there in former times by a more industrious and intelligent people. Artificial canals for watering the soil, and even for conveying its produce to distant places, appear to have been long used in the east. Mills were used in India of a very simple and ingenious construction for grinding grain. No threshing machine, however, appears to have been invented; and to this day, over all Asia, the corn is trodden out from the ear by the feet of cattle.

The Phœnicians, who inhabited the eastern coast of the Mediterranean, and are so frequently mentioned in the sacred Scriptures by the appellation of Philistines, (i. e. Palestines, or inhabitants of Palestine,) appear to have made considerable progress in agriculture. Being a maritime people, they carried their civilization and arts to various islands, and to several countries along the shores of the Mediterranean. Carthage was one of their colonies; and we know that, as early as the days of Herodotus, the part of Africa adjoining to that city, and which formed its territory to the westward,

History. ward, was inhabited by an agricultural people. As the Greeks derived the first rudiments of their literature from the Phœnicians, there can be little doubt of their having obtained their knowledge of agriculture from the same quarter.

Agriculture of the Greeks. Notwithstanding their constant wars, the situation of the Greeks appears upon the whole to have been favourable to agriculture. They were divided into a great variety of petty states, in which the territory was chiefly held by small proprietors who cultivated their own lands. The great population of the country, wasted as it so frequently was by intestine wars, could only be supported by considerable skill, or at least by great industry in agriculture.

Hesiod was the first known to us among the Greeks who wrote on this interesting subject. According to the custom of the Oriental authors, he wrote in poetry, and embellished his poem with luxuriant description and sublime imagery. He calls his poem *Works and Days*, because agriculture requires the exact observation of times and seasons.

Xenophon, in his *Oeconomics*, has remarked, that agriculture is the nursing mother of the arts. For, says he, “ where agriculture succeeds prosperously, there the arts thrive; but where the earth necessarily lies uncultivated, there the other arts are destroyed.”

Other eminent Greek writers upon agriculture were, Democritus of Abdera, Socratus, Archytas Tarentinus, Aristotle, and Theophrastus, from whom the art received considerable improvements.

Of the Romans. The state of agriculture among the ancient Romans merits a very particular degree of attention, on account of its influence upon the political destiny of that singular people. Histories of Rome and of the Romans are

INTRODUCTION.

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in the hands of all persons, and their military achievements, as well as civil dissensions, have been transmitted to us with minute care and accuracy by various writers. It is understood by few, however, that the Romans were only conquerors because they were cultivators of the soil, and that their love of war arose from their attachment to agriculture, and the independence and felicity which is enjoyed in that mode of life.

At the period when the foundation of Rome was laid, Italy appears to have been divided, as in later times, into a great multitude of petty states, destitute of any common bond of union. From the similarity of language, of institutions, and of religion, as well as from vicinity of situation, it appears certain that Italy must have been peopled by colonies from Greece. These colonies had arrived after the Greeks had made some progress in civilization; because we learn from history, that when Rome was founded, all the neighbouring states were acquainted with agriculture, and no people that is entirely barbarous can possess this art. At the date of the foundation of Rome Italy was only partially settled, like the United States of America, at the present day. Romulus appears to have acquired the property of a small district of a few miles over, upon which he resolved to establish a colony. With this view he invited settlers, by gratuitous offers of small portions of land; and, as the country was under no common government, he made his estate an asylum for runaway slaves. That he was no barbarian is evident from his adopting regulations founded upon the wisest maxims of colonial policy. He granted to every individual who chose to settle on his territory as much land as, when well cultivated, was accounted sufficient to support

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History. port a poor and frugal family (two jugera). His territory was soon stocked with small proprietors. The children of these persons, though bred up in frugal and laborious habits, were unable to find subsistence upon the small properties belonging to their parents. The country being destitute of commerce and manufactures, they had no other resource than that of emigrating in search of new lands. They had no money to purchase such lands; but, uniting into a body under the chief of their community, they attacked the weakest of the petty neighbouring states, and forced them to cede or make over to them some part of their territory. Thus the dominions of the petty chieftain of the Roman state were increased, while his young men were provided for by the shares which they received of the conquered lands, which were fairly and equally divided among them.

The new families which were settled in this way upon small properties, speedily cast out another swarm of hardy young men, trained up in frugality and the labours of agriculture, and therefore prepared to become most excellent soldiers. The same necessity which compelled their parents to invade their neighbours, obliged this new generation also to rest upon the success of their swords, their whole hopes of obtaining lands, on which to make use of the ploughshare. Thus war became necessarily the occupation of the Roman youth, that they might be enabled to pass their old age in the cultivation of the soil. The territory of Rome became a nursery of soldiers. Her armies were invincible, because the individuals of which they were composed, being young men of a robust constitution, and frugal and laborious habits, urged on by want, and engaged in a contest for what

what they accounted riches and independence, seldom encountered their equals in fortitude and courage, and never failed to persevere in every struggle, till they were either successful or exterminated. It is true, that no nation ever suffered greater or more frequent defeats than the Romans in war; and in the management of their campaigns and battles, they often committed the most gross military errors: but these were rendered of no importance to the general history of the people, in consequence of their agricultural policy, which enabled them at all times to renew the war by means of new swarms of military adventurers, the sons of their peasantry. Hence, also, they never lost a foot of territory that they once gained; because the conquering army consisted of young men who had no intention of returning home, but who instantly settled upon the lands which they had subdued. A Roman army was thus a colony of husbandmen, who made war with the same views, with which the original settlers in North America made war upon the savages or native inhabitants of the country, that is, that they might seize, and cultivate, and inhabit their lands. The Romans, indeed, were not superior in arts to their immediate neighbours; and hence, their contest for dominion was long and arduous, and owed its ultimate success merely to the institutions of * Romulus the founder of the state, the spirit of which, his

* The learned reader will easily recollect authorities which illustrate and confirm what is here stated. *Ac primus agros quos bello Romulus ceperat, divisit viritim civibus.* *Cic. de Republica, lib. 2.*

Quantum attinet ad antiquos nostros ante bellum Punicum pendebant bina jugera, quod a Romulo primum divisa dicebantur viritim. **VARRO** *de Re Rustica, lib. 1. cap. 10.*

History. his successors, whether kings or consuls, appear (with the exception of Numa) to have well understood, and for some ages to have correctly and zealously carried into effect.

By degrees, indeed, the fundamental maxims, that is to say, the agricultural maxims of Roman policy, were disregarded. Like other states, they at last engaged in war not merely to provide for their supernumerary youth, but from a love of national power and aggrandizement. They gave pay to their soldiers, and kept them long in the service. They no longer divided among these hired troops the lands, or a large portion of the lands conquered in war, but set them up to sale, or left them to be held for a tribute, which was spent in corrupting the populace of the capital. Still, however, the whole history of Rome, from its earliest to its latest period, exhibits proofs that the labours of agriculture, even when unattended by riches, were held in higher estimation than they have ever been by any other European nation. The religion of the state connected itself in a peculiar manner with this art, and impressed upon it a great degree of respectability. The people were taught to believe, that the † supreme divinity was the first who instructed

'Tandem pro multis vix jugera bina dabantur
Vulneribus. JUVENAL, Sat. 14. lib. 5.

Multis legionibus contigit bellum feliciter tranfigere, et ad gloriosam agriculturæ requiem primo tyrcinii gradu pervenire, cum signis et aquila et primis ordinibus et tribunis deducebantur. HYGINUS.

† Ante Iovem nulli subigebant arva coloni. VIRG. Georg. lib. 1.
Dique Deoque omnes studium quibus arva tueri,
Quique novas alitis nullo de semine fruges,
Quique satis largum cœlo demittit: imbre. Id. lib. 1.

Pan

structed men in the art of agriculture; and a variety of inferior deities were represented as presiding over the different fruits of the earth, and the operations of nature in bringing these fruits to maturity, to reward the toil of the husbandman. In all the seasons of the year, different festivals were appointed, upon which the magistrates went in procession to the temples of the gods, and sometimes to the fields, to offer up prayers for the safety of the crop, or of the cattle, and for success in every agricultural undertaking.

The political institutions of the state were all calculated in a similar manner to confer respectability upon the practice of this art. In the early ages of the republic, the individual soldiers of a victorious army were each put in possession of his portion of the conquered territory, with all the solemnity and parade of a military procession, thereby giving dignity to the labours of the husbandman, by associating them with the proud ideas of conquest and dominion. Hence, the persons engaged in any branch of art or manufacture, or in any commercial employment, were regarded as an inferior class, and as holding a far lower rank in society than the meanest husbandman, or person engaged in the cultivation of the soil. One of the punishments which the public censors or inspectors of morals, sometimes inflicted upon a disorderly citizen, consisted of striking his name out of the list of the inhabitants of the country, and of enrolling him among the city tribes.

The

Pan curat oves oviumque magistros, Et ruber, hortorum decus et tutela Priapus. Populus Alcida gratissima, vitis Iaccho. Montium custos nemorumque virgo.	VIRG. <i>Eclig.</i> OVID. <i>Faf.</i> lib. 1. VIRG. <i>Eclig.</i> 7. HORAT. <i>Ode</i> 16. lib. 1.
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History. The very high degree of respect in which agriculture was held among the ancient Romans, explains what has often appeared a strange circumstance in their history, that after they had made considerable conquests, they should still have employed as consuls, dictators, and commanders of mighty armies, men accustomed to support themselves by holding the plough upon their own farms. In this there is nothing wonderful. Among the Romans, the husbandmen were accounted the most respectable order of society. Their morals were the purest, and the young men of this class formed the military strength of the state. As in modern Europe, a nobleman or gentleman with little private property, is often employed to conduct fleets and armies, on account of the respectability of his birth, talents, and education; the Romans in like manner disregarded private wealth in the choice of their leaders, but at the same time selected them from the most respectable and warlike, that is, the agricultural class of their citizens. Examples of this sort of preferment, tended to preserve to a very late period a taste for agriculture and for frugal manners. Hence, the most illustrious senators of the empire, in the intervals of public concerns, applied themselves to this profession; and such was the simplicity of those ages, that they assumed no appearance of magnificence and splendour, or of majesty, but when they appeared in public. At their return from the toils of war, the taking of cities, and subduing of hostile nations, their greatest generals were impatient till they were again employed in the arts of cultivation.

Regulus, when in Africa, requested of the senate to be recalled, lest his farm might suffer, for want of proper cultivation, in his absence; and the senate wrote

him for answer, that it should be taken care of at the ^{History.} public expence, while he continued to lead their armies.

Cato the censor, after having governed extensive provinces, and subdued many warlike nations, did not think it below his dignity to write a Treatise on Agriculture. This work (as we are told by Servius) he dedicated to his own son, it being the first Latin treatise written on this important subject; and it has been handed down to us in all its purity, in the manner that Cato wrote it.

Varro composed a treatise on the same subject, and on a more regular plan. This work is embellished with all the Greek and Latin erudition of that learned author, who died 28 years before the commencement of the Christian æra. Virgil, who lived about the same time, has, in his Georgics, adorned this subject with the language of the Muses, and finely illustrated the precepts and rules of husbandry laid down by Hesiod, Mago, and Varro.

Columella, who flourished in the reign of the emperor Claudius, wrote 12 books on husbandry, replete with important instruction.

From this period to that of the reign of Constantine Paganatus, husbandry continued in a declining state; but that wise emperor caused a large collection of the most useful precepts relating to agriculture to be extracted from the best writers, and published them under the title of *Geponics*. It has been asserted, that he made this collection with his own hand; and the truth of the assertion is not improbable, as it is well known, that after he had conquer'd the Saracens and the Arabians, he not only practised and encouraged, but studied

History. the arts of peace, fixing his principal attention on agriculture, as their best foundation.

After the death of Constantine, however, the increasing attention of the people to commerce, and the ignorance and gross superstition of the ages which succeeded, seem to have rendered agriculture an almost neglected science. The irruptions of the northern nations soon abolished any improved system. These innumerable and enterprising barbarians, who overran all Europe, were originally shepherds or hunters, like the present Tartars and the savages of America. They contented themselves with possessing, without labour or trouble, those vast countries rendered deserts by their own ravages, cultivating only a very small spot near their habitations; and in this trifling husbandry only the meanest slaves were employed: so that the art itself, which formerly was thought worthy of the study of kings, was now looked upon as mean and ignoble; a prejudice which is scarcely effaced at present, or at least but very lately.—During this period, therefore, we find no vestiges of any thing tolerably written on the subject.

The earliest efforts that were made in Europe towards the restoration of agriculture, after the conquest by the northern and eastern swarms of barbarians, appear to have occurred in Italy, which, after all its misfortunes, still continued to take the lead of the western world, in whatever regarded the civilization of mankind and the improvement of the useful arts. But as the barbarians had introduced a pernicious notion, which remained long fashionable in Europe, that labour was disgraceful, and more especially that kind of labour which is employed in the cultivation of the soil, it was long before

before historians began to take notice of agricultural improvements, or of any other events than those petty wars which were at that period continually taking place among the free cities and feudal chieftains. One circumstance, however, deserves attention, as it sufficiently marks the progress in agriculture that had been made by the Italians at a very early period; works of great expence and magnificence were formed in Lombardy during the middle ages, for the purpose of irrigation or with a view to water the soil.

As the irrigation of the Milanese is perhaps the greatest exertion of the kind that the world exhibits, and certainly was the first that was undertaken in Europe, after the decline of the Roman empire, it undoubtedly merits every attention, and ought to be held up to the view of the people of Great Britain, as an object in many instances well deserving imitation. The water is there conveyed to every district of the country, in extensive and noble canals, from which the great lands belonging to private persons are periodically watered. All rivers or running streams are declared by law to belong to the sovereign, who sells the waters to speculators for the beneficial purpose of irrigation. It is sometimes measured out by the length of time a certain quantity of water is allowed to run upon the lands, and sometimes a stream of water proceeding through a tube or hole of a certain diameter from a canal, is sold or let at the highest price it will bring. The property of such streams of water derived from canals, is often held in perpetuity, and disposed of by a separate tenure from the land. The practice is found so profitable both to the public and to private individuals, that the whole country, as far as possible, is intersected with canals, formed for the

History. purpose of conveying water to the lands. Every considerable spring that is found, becomes the origin of a new canal. He who discovers a spring, conducts it where he pleases, paying a fixed compensation for cutting through the properties of others. " As an example of the beneficial influence of this law, (says Mr Arthur Young *) I was shewn between Milan and Pavia a spring, that was discovered two miles from the lands of the discoverer, the properties of many persons lying between him and the spring. He first bought the property of the person in whose lands it was situated, which was easily done, as it was too low to be there of any use; then he conducted it by a trench at pleasure the two miles, paying the fixed price for cutting through his neighbours lands, and having gained it upon his own, presently changed poor hungry arable gravel into a very fine watered meadow." In the neighbourhood of the cities of Milan and of Lodi, the exertions in irrigation are the greatest. Canals are not only numerous and uninterrupted, but are conducted with great skill and expence. Along the public roads there is almost everywhere one canal on the side of the road and sometimes two. Cross ones are thrown over these on arches, and pass in trunks of brick or stone under the road. A very considerable one, says the above author, " after passing for several miles by the side of the highway, sinks under it, and also under two other canals carried in stone troughs eight feet wide; and at the same place under a smaller that is conducted in wood. The variety

* *Travels*, vol. ii.

nity of directions in which the water is carried, the ease with which it flows in contrary directions, the obstacles which are overcome, are objects of admiration. The expence thus employed, in the 20 miles from Milan to Lodi, is immense. There is but little rice, and some arable, which does not seem under the best management, but the grass and clover rich and luxuriant; and there are some great herds of cows, to which all this country ought to be applied. I cannot but esteem the 20 miles, as affording one of the most curious and valuable prospects in the power of a farmer to view. We have some undertakings in England that are meritorious; but they sink to nothing in comparison with these great and truly noble works. It is one of the rides which I wish those to take who think that every thing is to be seen in England."

It is not easy, amidst the darkness of the middle ages, to discover the precise period at which these interesting and valuable works were begun. In the year 1037, however, mention is made of the canal Vecchiabbia. In 1067, watered meadows were common, called *pratucco* by Landolfo. In 1077 there are notes of many streams used. In 1138, the monks of Chiarevalle bought of Giovanni Villano some commons, woods, and meadows, for 81 livres, under the contract, (a parchment yet remaining) "ut monasterium possit ex Vecchiabbia trahere lectum ubi ipsum monasterium voluerit; et si fuerit opus, liceat facere eidem monasterio fossata super terram ipsius Johannis ab ima parte vice et ab alia . . . &c. Possit firmare et habere clusam in prato ipsius Johannis, &c." There is a similar contract of the following year, and various others until the beginning of the 13th century; from which, and others, it appears that the Vecchiabbia

History. was the entire property of the monastery, and confirmed in 1276 by the diploma of the emperor Frederick II. The merit of these monks appears to have been great, for they gained such a reputation for their skill and industry, that they had many applications for assistance in directing works similar to their own upon uncultivated lands ; and the imperial chancellor Rinaldo, in the time of the emperor Frederick I. being appointed archbishop of Cologne, found the possessions of his see in such a deplorable state, that he applied for, and received the same assistance, as reported by Cesario Eisterbacense. Their greatest exertions were in irrigation, which was so well known, that they sold their superfluous water, transferring the use and property of some by the hour, day, and week. In two centuries they came to be possessed of 60,000 pertiche, mostly watered. There is reason to believe that the practice in the 13th century did not materially differ from the present modes; because in the papers of the archives of the abbey, of that period, mention is made of *chieuse* or sluices, *incasfri* or water-gates that are moved perpendicularly, *bochilli* or openings in the banks to distribute the water, *foratoi* or *scaricatori*, discharges for carrying off superfluous water, and other works to distribute the water and regulate the irrigation. In 1164, the emperor Frederick gave various rights in certain rivers to the people of Pavia, for the purposes of irrigation. In 1177, the people of Milan enlarged and continued the Navillio Grande, from Abbiate Grasso to Milan, being 14 miles ; it was brought from the Tesino near the Lago Maggiore to Abbiate Grasso, 20 miles, by the people of Pavia, long before the date of any records now known to remain. In 1271, it was made navigable.

gable; It is 32 Italian miles long, and 25 braccia wide, History.
or 49 English feet.

In 1220 was executed the second great work or canal of this kind, which conveys the waters of the Adda from Caffano to Marignano, where it waters much of the country around Lodi. In 1305, the canal of Treviglio was made, which takes the waters from the Brembo, and carries them for several miles, about 25 feet wide, and about three deep ; it irrigates the territory of Treviglio and the Chiara d'Adda ; and within four or five miles there are five canals, taken from the Adda and the Brembo, all of great antiquity. In 1460, the canal de Martesano was begun under Duke Francis Sforza I. ; it was 24 miles long, and 18 braccia (35 English feet) wide ; since lengthened seven or eight miles more. It takes the waters of the Adda, a little before Trezzo, by means of a powerful weir (chiuse) founded upon the living rock : it is then supported for five miles by a solid wall of stone 40 braccia (80 feet) above the bottom of the Adda, and parallel with it. At Gorgonsola, it passes over the torrent Molgora by a bridge of three stone arches. At Carsenfago it is crossed by the river Lambro, which enters and quits the canal with all its floods. And in order to prevent the surplus of water which this circumstance occasions, from breaking the banks of the canal, or overflowing them, there are 19 *scaricatori* in the canal, above, below, and facing the junction, which are so calculated that they have not only powers sufficient to take off the waters of that river, but also half of those of the canal itself. These *scaricatori* are canals which take the water when sluice-gates are opened for that purpose, and convey it at various distances to the Lambro again, the fall in its course.

History. course being considerable enough to free the canal from all superfluity of water. The chief of these canals are so contrived as to be completely emptied once a-year, for cleaning and repairing whatever accidents may have happened to any of the works. These facts show how well that important branch of agriculture, which consists of irrigation, and which is only of recent introduction among ourselves, was understood in Italy, and how admirably it was practised when the countries on this side of the Alps were altogether barbarous.

On the general subject of agriculture at large, however, few Italian writers appeared till towards the end of the 15th century. In 1478 Crescenzi published an excellent performance on the subject at Florence. This roused the slumbering attention of his countrymen, several of whom soon followed his example. Among these, Tatti, Steffano Augustino Gallo, Sansovino, Lauro, and Tarello, deserve particular notice.

At what time agriculture was introduced into Britain, is uncertain. When Julius Cæsar first invaded this island, it was not wholly unknown. That conqueror was of opinion, that agriculture was first introduced by some of those colonies from Gaul which had settled in the southern parts of Britain, about 100 years before the Roman invasion*.

It is not to be expected that we can now be acquainted with many of the practices of these ancient husbandmen. It appears, however, that they were not unacquainted with the use of manures, particularly manl.

* Cæsar *de Bell. Gall.* lib. v. c. 12.

marl. This we have on the authority of Pliny †, who History.
tells us, that it was peculiar to the people of Gaul and
of Britain; that its effects continued 80 years; and
that no man was ever known to marl his field twice,
&c.—It is highly probable, too, that lime was at this
time also used as a manure in Britain, it being certainly
made use of in Gaul for this purpose at the time of
Julius Cæsar's invasion.

The establishment of the Romans in Britain produced great improvements in agriculture, insomuch that prodigious quantities of corn were annually exported from the island; but when the Roman power began to decline, this, like all the other arts, declined also, and was almost totally destroyed by the departure of that people. The unhappy Britons were now exposed to frequent incursions of the Scots and Picts, who destroyed the fruits of their labours, and interrupted them in the exercise of their art. After the arrival of the Saxons in the year 449, they were involved in such long wars, and underwent so many calamities, that the husbandmen gradually lost much of their skill, and were at last driven from those parts of their country which were most proper for cultivation.

After the Britons retired into Wales, though it appears from the laws made relative to this art, that agriculture was thought worthy of the attention of the legislature, yet their instruments appear to have been very unartful. It was enacted that no man should undertake to guide a plough who could not make one; and that the driver should make the ropes of twisted willows,

with

† Plin. *Nat. Hist.* lib. xvii, cap. 6.

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History. with which it was drawn. It was usual for six or eight persons to form themselves into a society for fitting out one of these ploughs, providing it with oxen and every thing necessary for ploughing; and many minute and curious laws were made for the regulation of such societies. If any person laid dung on a field with the consent of the proprietor, he was by law allowed the use of that land for one year. If the dung was carried out in a cart in great abundance, he was to have the use of the land for three years. Whoever cut down a wood, and converted the ground into arable, with the consent of the owner, was to have the use of it for five years. If any one folded his cattle, for one year, upon a piece of ground belonging to another, with the owner's consent, he was allowed the use of that field for four years.

Thus, though the Britons had in a great measure lost the knowledge of agriculture, they appear to have been very assiduous in giving encouragement to such as would attempt a revival of it; but, among the Anglo-Saxons, things were not at present in so good a state. These restless and haughty warriors, having contracted a distaste and contempt for agriculture, were at pains to enact laws to prevent its being followed by any other than women and slaves. When they first arrived in Britain, they had no occasion for this art, being supplied by the natives with all the necessaries of life. After the commencement of hostilities, the Saxons subsisted chiefly by plunder: but having driven out or extirpated most of the ancient Britons, and divided their lands among themselves, they found themselves in danger of starving, there being now no enemy to plunder;

der: and therefore they were obliged to apply to agriculture. History.

The Saxon princes and great men, who, in the division of the lands, had received the greatest shares, are said to have subdivided their estates into two parts, which were called the *in-lands* and the *out-lands*. The *in-lands* were those which lay most contiguous to the mansion-house of their owner, which he kept in his own possession, and cultivated by his slaves, under the direction of a bailiff, for the purpose of raising provisions for the family. The *out-lands* were those at a greater distance from the house, and were let to the *cearks*, or farmers of those times, at very moderate rents. By the laws of Ina king of the West Saxons, who reigned in the end of the seventh and beginning of the eighth century, a farm consisting of ten hides, or plough-lands, was to pay the following rent: "Ten casks of honey; three hundred loaves of bread; twelve casks of strong ale; thirty casks of small ale; two oxen; ten wedders; ten geese; twenty hens; ten cheeses; one cask of butter; five salmon; twenty pounds of forage; and one hundred eels." From this low rent, the imperfection of agriculture at that time is easily discoverable; but it is still more so from the low prices at which land was then sold. In the ancient history of the church of Ely, published by Dr Gale, there are accounts of many purchases of lands by Ædelwold the founder of that church, and by other benefactors, in the reign of Edgar the Peaceable, in the tenth century. By a comparison of these accounts it appears, that the ordinary price of an acre of the best land in that part of England, in those times, was no more than 16 Saxon pennies, or about four shillings of our

Henry. our money : a very trifling price, even in comparison with that of other commodities at the same time : for, by comparing other accounts, it appears, that four sheep were then equal in value to an acre of the best land; and one horse of the same value with three acres. The frequent and deplorable famines which afflicted England about this time, are further instances of the wretched state of agriculture. In 1043, a quarter of wheat sold for 60 Saxon pennies ($\frac{1}{3}$ of our shillings), at that time equal in value to seven or eight pounds of our money now.

The invasion of the Normans, in 1066, contributed very much to the improvement of agriculture ; for, by that event, many thousands of husbandmen from Flanders, France, and Normandy, settled in Britain, obtained estates or farms, and cultivated them after the manner of their country. The implements of husbandry, used at this time, were of the same kind with those employed at present ; but some of them were less perfect in their construction. The plough, for example, had but one stilt or handle, which the ploughman guided with one hand, having in his other hand an instrument which served both for cleaning and mending the plough, as well as for breaking the clods. The Norman plough had two wheels ; and in the light soil of Normandy was commonly drawn by one or two oxen ; but, in England, a greater number was often necessary. In Wales, the person who conducted the oxen in the plough walked backwards. Their carts, harrows, scythes, sickles, and flails, from the figures of them still remaining, appear to have been nearly of the same construction with those that are now used. In Wales, they did not use a sickle for reaping their corns,

but

but an instrument like the blade of a knife, with a History. wooden handle at each end.—Their chief manure, next to dung, seems still to have been marl. Summer following of lands designed for wheat, and ploughing them several times, appear to have been frequent practices of the English farmers in this period.

We are, after all, very much in the dark with respect to the state and progress of agriculture in Great Britain previous to the fourteenth century. That it was pretty generally practised, especially in the eastern, south, and midland parts of England, is certain; but of the mode, and the success, we are left almost totally ignorant. In the latter end of the fifteenth century, however, it seems to have been cultivated as a science, and received very great improvement.

At this time Fitzherbert, judge of the common-pleas, shone forth with distinguished eminence in the practical parts of husbandry. He appears to have been the first Englishman who studied the nature of soils and the laws of vegetation with philosophical attention. On these he formed a theory confirmed by experiments; and rendered the study pleasing as well as profitable, by realizing the principles of the ancients, to the honour and advantage of his country. Accordingly, he published two treatises on this subject: the first, intituled *The Book of Husbandry*, appeared in 1534; and the second, called *The Book of Surveying and Improvements*, in 1539. These books, being written at a time when philosophy and science were but just emerging from that gloom in which they had long been buried, were doubtless replete with many errors; but they contained the rudiments of true knowledge, and revived the study and love of an art, the advantages of which

History. were obvious to men of the least reflection. We therefore find that Fitzherbert's books on agriculture soon raised a spirit of emulation in his countrymen ; and many treatises of the same kind successively appeared, which time has however deprived us of, or at least they are become so very scarce as only to be found in the libraries of the curious.

In England, during the civil wars, though the operations and improvements in husbandry suffered some temporary checks, there flourished several excellent writers on the subject, and the art itself received considerable encouragement. Sir Hugh Platt was one of the most ingenious husbandmen of the age in which he lived ; yet so great was his modesty, that all his works, except his *Paradise of Flora*, seem to be posthumous. He held a correspondence with most of the lovers and patrons of agriculture and gardening in England ; and such was the justice and modesty of his temper, that he always named the author of every discovery communicated to him. Perhaps no man in any age discovered, or at least brought into use, so many new kinds of manure. This will be evident to those who read his account of the compost and covered dunghills, and his judicious observations on the fertilizing qualities lodged in salt, street dirt, and the sullage of streets in great cities, clay, fullers earth, moorish earths, dunghills made in layers, fern, hair, calcination of all vegetables, malt dust, willow tree earth, soapers ashes, urine, marl, and broken potsherds.

Gabriel Platten may be said to have been an original genius in husbandry. He began his observations at an earlier period, in the reign of Queen Elizabeth, and continued them down to the Commonwealth. But notwithstanding

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Notwithstanding the great merit of this writer, and the essential service he had rendered his country by his writings, the public ungratefully suffered him to starve and perish in the streets of London ; nor had he a shirt on his back when he died. History.

Among these we may mention the writings of Captain Walter Blyth, on account of the very complete manner in which he appears to have understood the subject of irrigation or watering lands. In his principal work, called the *English Improver improved*, published in 1652, he gives directions for the practice of this branch of the art which mark great intelligence and observation, and would do no discredit to the experience of our own age.

Samuel Hartlib, a celebrated writer on agriculture in the 17th century, was highly esteemed and beloved by Milton, and other great men of his time. In the preface to his work entitled his *Legacy*, he laments that no public director of husbandry was established in England by authority ; and that we had not adopted the Flemish method of letting farms upon improvement. This remark of Hartlib's procured him a pension of 100l. a-year from Cromwell ; and the writer afterwards, the better to fulfil the intention of his benefactor, procured Dr Beattie's excellent annotation on the *Legacy*, with other valuable papers from his numerous correspondents.

The time in which Hartlib flourished seems to have been an era when the English husbandry rose to great perfection, compared with that of former ages ; for the preceding wars had impoverished the country gentlemen, and of course made them industrious. They found the cultivation of their own lands to be the most profitable

History. profitable station they could fill. But this wise turn was not of long continuance. At the Restoration, they generally became infected with that intoxication and love of pleasure which succeeded. All their industry and knowledge were exchanged for idleness and dissipation; and husbandry descended almost entirely into the hands of common farmers.

Evelyn was the first writer who inspired his countrymen with a desire of reviving the study of agriculture; and he was followed by the celebrated Jethro Tull. The former, by his admirable treatises on earth and on planting, and the latter, by contending for the superior advantages of the drill husbandry, excited numbers to bring their theory to the test of fair experiment.

Many valuable and capital improvements have since that period been made in English husbandry: and these great men have been succeeded by a variety of writers, who have performed the most essential service to their countrymen, by enlightening their minds, and exciting them to emulation in this important art.

About the middle of the last century, Ireland began to make a considerable figure in the art of husbandry. It must indeed be confessed, that the Irish had very strong prejudices in favour of a wretched method of agriculture, till Blyth opened their eyes by his excellent writings. Since that time, a spirit of improvement has more or less been promoted, and in many instances carried on with great zeal, by the nobility, clergy, and gentry of that kingdom. In proof of this, it will be sufficient to observe, that the Transactions of the Dublin Society for encouraging Husbandry are now quoted by all foreigners in their memoirs relating to that subject. And the observations of that discerning and judicious

dicious writer, Arthur Young, Esq. in his Tour through History. that kingdom, shew, that in many respects improvements there have of late years made a progress nearly as rapid as in England.

About the year 1600, France made some considerable efforts to revive the art of husbandry, as appears from several large works, particularly *Les Moyens de devenir Riche*; and the *Cosmopolite*, by Bernard de Palissy, a poor porter, who seems to have been placed by fortune in a station for which nature never intended him; *Le Theatre d'Agriculture*, by Deferres; and *L'Agriculture et Maison Rustique*, by Messrs Etienne, Liebault, &c.

Nearly in the same period, the skilful practice of husbandry became more prevalent among the Flemings, than the publishing of books on the subject. Their intention seemed to be that of carrying on a private lucrative employment, without instructing their neighbours. Whoever therefore became desirous of copying their method of agriculture, was obliged to visit that country, and make his own remarks on their practice.

The principal idea they had of husbandry was, by keeping the lands clean and in fine tilth, to make a farm resemble a garden as nearly as possible.

Such an excellent principle, at first setting out, led them of course to undertake the culture of small farms only, which they kept free from weeds, continually turning the ground, and manuring it plentifully and judiciously. When they had by this method brought the soil to a proper degree of cleanliness, health, and sweetnes, they chiefly cultivated the more delicate grasses, as the surest means of obtaining a certain pro-

History. fit upon a small estate, without the expence of keeping many draught horses and servants. A few years experience was sufficient to convince them, that ten acres of the best vegetables for feeding cattle, properly cultivated, would maintain a larger stock of grazing animals than forty acres of common farm grases on land badly cultivated. They also found, that the best vegetables for this purpose were lucerne, saintfoin, trefoil of most kinds, field-turnips, &c.

The grand political secret of their husbandry, therefore consisted in letting farms on improvement. They are said also to have discovered nine sorts of manure; but what they all were, we are not particularly informed. We find, however, that marl was one of them; the use and virtues of which appear also to have been well known in this kingdom two hundred years ago, although it was afterwards much neglected. They were the first people among the moderns who ploughed in green crops for the sake of fertilizing the soil; and who confined their sheep at night in large sheds built on purpose, the floors of which were covered with sand or virgin earth, &c. which the shepherd carted away each morning to the compost dunghill.

After the peace of Aix-la-Chapelle, most of the nations of Europe, by a sort of tacit consent, applied themselves to the study of agriculture, and continued to do so, more or less, amidst the universal confusion that succeeded.

The French found, by repeated experience, that they could never maintain a long war, or procure a tolerable peace, unless they could raise corn enough to support themselves in such manner as not to be obliged to submit to harsh terms on the one hand, or to perish

by

by famine on the other. This occasioned the king to History. give public encouragement to agriculture, and even to be present at the making of several experiments. The great, and the rich of various ranks and stations, followed his example; and even the ladies were candidates for a share of fame in this public-spirited and commendable undertaking.

During the hurry and distresses of France in the war of 1756, considerable attention was paid to agriculture. Prize questions were annually proposed in their rural academies, particularly those of Lyons and Bourdeaux; and many judicious observations were made by the Society for improving agriculture in Britanny.

After the conclusion of that war in 1763, matters were carried on there with great vigour. The university of Amiens made various proposals for the advancement of husbandry; and the marquis de Tourbilly (a writer who proceeded chiefly on experience) had the principal direction of a georgical or agricultural society established at Tours.

The society at Rouen, which made a considerable figure at the same period, also deserves notice. In consequence of encouragement from the government, there soon existed about fifteen societies in France, established by royal approbation, for the promoting of agriculture; and these had twenty co-operating societies belonging to them.

After all, however, the history of the kingdom of France affords a striking example how little can be done towards the improvement of agriculture, by the mere efforts of government, or of speculative men, in publishing books or offering premiums for treatises upon the subject. The agriculture of the country at large, notwithstanding all that was done in this way, still

History. continued in a very deplorable state. In the years 1787, 1788, and 1789, when Mr Young made his agricultural tour upon the continent, it was supposed that nearly seven-eighths of the lands in France were held by *metayers*, that is, by the tenure which in Scotland anciently received the appellation of *feet-bow*, and which to this day is not unknown in the Highland districts. By this tenure the landlord or proprietor stocked the farm with seed corn, cattle, and implements of husbandry, while the tenant afforded nothing more than his labour. The produce was divided between the two parties in such proportion as they could agree upon. "This tenure," says Mr Young, "pervades almost every part of Sologne, Berry, La Marche, Limosin, Anjou, Bourgogne, Bourbonnois, Nivernois, Auvergne, &c. and is found in Bretagne, Maine, Provence, and all the southern counties, &c. In Champagne there are many at *tier franc*, which is the third of the produce, but in genera it is half. The landlord commonly finds half the cattle and half the seed; and the metayer labour, implements, and taxes: but in some districts the landlord bears a share of these. In Berry some are at half, some one-third, some one-fourth produce. In Roussillon the landlord pays half the taxes; and in Guienne, from Auch to Fleuran, many landlords pay all. Near Aguillon on the Garonne, the metayers furnish half the cattle. Near Falaise in Normandy I found *metayers*, where they should least of all be looked for, on the farms which gentlemen keep in their own hands; the consequence there is that every gentleman's farm must be precisely the worst cultivated of all the neighbourhood. This disgraceful circumstance needs no comment. At Nangis, in the Isle of France, I met with an agreement for

for the landlord to furnish live-stock, implements, harness, and taxes; the metayer found labour and his own capitulation tax; the landlord repaired the houses and gates, the metayer the windows; the landlord provided seed the first year, the metayer the last; in the intervening years they supply half and half—Produce sold for money divided. Butter and cheese used in the metayer's family, to any amount, compounded for at 5s. a cow. In the Bourbonnois the landlord finds all sorts of live-stock; yet the metayer sells, changes, and buys at his will, the steward keeping an account of these mutations; for the landlord has half the product of sales, and pays half the purchases. The tenant carts the landlord's half of the corn to the barn of the chateau, and comes again to take the straw. The consequences of this absurd system are striking; land, which in England would let at 10s. pays about 2s. 6d. for both land and live-stock."

History.

"The tenants," adds this excellent and accurate observer, are found in the lowest state of poverty, and some of them in misery. At Vatan in Berry I was assured that the metayers almost every year borrowed their bread of the landlord before the harvest came round, yet hardly worth borrowing, for it was made of rye and barley mixed. I tasted enough of it to pity the poor people; but no common person there eats wheaten bread. With all this misery among the farmers the landlord's situation may be estimated by the rents he receives. At Salbris in Sologne, for a sheep-walk that feeds 700 sheep, and 200 English acres of other land, paid the landlord for his half about 33l. sterling: the whole rent for land and stock too did not, therefore, amount to 1s. per head on the sheep! In Limosin the metayers are consider-

Histoire ed as little better than mortal serfs, removable at pleasure, and obliged to conform in all things to the will of the landlords. It is commonly computed, that half the tenantry are deeply in debt to the proprietors, so that he is often obliged to turn them off, with the loss of these debts, in order to save his land from running waste." The hard plea of necessity, continues the same author, can alone be urged in favour of this mode of cultivating land; "the poverty of the farmers being so great, that the landlord must stock the farm, or it could not be stocked at all. This is a most cruel burden to a proprietor, who is thus obliged to run much of the hazard of farming, in the most dangerous of all methods, that of trusting his property absolutely in the hands of people who are generally ignorant, many careless, and some undoubtedly wicked. Among some gentlemen I personally knew, I was acquainted with one at Bagnere de Luchon, who was obliged to sell his estate, because he was unable to restock it; the sheep having all died of epidemical distempers, proceeding doubtless from the execrable methods of the metayers, cramming them into stables, as hot as stoves or reeking dunghills; and then, in the common custom of the kingdom, shutting every hole and crack that could let in air. In this most miserable of all modes of letting land, after running the hazard of such losses, fatal in many instances, the defrauded landlord receives a contemptible rent—the farmer is in the lowest state of poverty—the land is miserably cultivated, and the nation suffers as severely as the parties themselves."

The great evil which prevented the tenantry of France from attaining to that respectable and easy situation which they have reached in Great Britain, and which

which the publication of books, and the efforts of agricultural societies could not remove, was the improper principles upon which their revenue laws have at all times been conducted. Heavy taxes were imposed upon the farmers, from which the nobles and the clergy were exempt. These taxes were imposed arbitrarily upon individuals, according to the estimate formed of their wealth by the intendant of the province and his delegates ; the result of which was, that although the sovereign received only a moderate revenue into his exchequer, the cultivators of the soil were oppressed, in consequence of the partiality with which the taxes were imposed, according to the favour or dislike of the inferior officers of the revenue. Hence the farmers, even when not really poor, pretended to be so, to escape the arbitrary rise of a tax which was professedly imposed in proportion to their power of bearing it : They chose therefore to have poor cattle, poor implements of husbandry, and poor dunghills, even when they could have done otherwise. The result of the whole was, that the husbandry of by far the greater part of France never rose above a very low state. They have in general no better mode of ameliorating the soil than merely by the use of a fallow year after every two white crops, the consequence of which is, that notwithstanding their fine climate, and their fertile soil, the produce of the British islands on a given extent of arable territory, is incomparably superior to that of France ; a circumstance which perhaps affords some explanation of the political equality which has long existed between the two countries, notwithstanding the magnitude of France and the natural advantages of its territory. As it is an important fact in the history of agriculture, that, of two rival

History. nations, situated in the close vicinity of each other, the one should have possessed this art in a very high degree of perfection, while in the other it should have remained in such a state of inferiority as could not fail to produce much weakness in every national effort; we shall here state the comparison made by Mr Young between the result of French and English agriculture, in the production even of wheat, which is the French favourite crop.

"In order, (says this author), the better to understand how the great difference of product between the French and English crops, may affect the agriculture of the two kingdoms, it will be proper to observe that the farmer in England will reap as much from his course of crops, in which wheat and rye occur but seldom, as the Frenchman can from his in which they return often.

AN ENGLISH COURSE.

	Bushels per acre.		Bushels per acre.
1. Turnips,		1. Fallow,	
2. Barley,		2. Wheat, 18	
3. Clover,		3. Barley or oats,	
4. Wheat, 25		4. Fallow,	
5. Turnips,		5. Wheat, 18	
6. Barley,		6. Barley or oats,	
7. Clover,		7. Fallow,	
8. Wheat, 25		8. Wheat, 18	
9. Tares or beans,		9. Barley or oats,	
10. Wheat, 25		10. Fallow,	
11. Turnips,		11. Wheat, 18	

75

72

" The

INTRODUCTION.

41

“ The Englishman in eleven years gets three bushels more of wheat than the Frenchman. He gets three crops of barley, tares, or beans, which produce nearly twice as many bushels per acre as what the three French crops of spring corn produce. And he farther gets at the same time three crops of turnips and two of clover, the turnips worth 40s. the acre, and the clover 60s. that is, 12l. for both. What an enormous superiority! more wheat; almost double of the spring corn; and above 20s. per acre per annum in turnips and clover. But farther; the Englishman’s land, by means of the manure arising from the consumption of the turnips and clover is in a constant state of improvement, while the Frenchman’s farm is stationary. Throw the whole into a cash account, and it will stand thus:”

ENGLISH SYSTEM.	FRENCH SYSTEM.
Wheat 75 bushels at 5s. L.18 15 0	Wheat 72 bushels at 5s. L.18 0 0
Spring corn 3 crops at 32s. 96 bushels at 2s. 6d.	Spring corn 3 crops at 20 bushels, 60 bushels at 2s. 6d.
Clover two crops 6 0 0	7 10 0
<hr/> 36 15 0	<hr/> 25 10 0
Per acre per annum, 3 6 10	Per acre per annum, 2 6 4

“ In allowing the French system to produce 20 bushels of spring corn, while I assign 32 only to the English, I am confident that I favour the former considerably; for I believe the English produce is the double of that of France; but stating it as above, here are the proportions of 36 on an improving farm, to 25 on a stationary one; that is to say, a country containing

History. ing 82,000,000 acres produces as much as another whose area contains 119,000,000, which are in the same ratio as 36 and 25."

The effect of the French revolution upon the situation of the persons immediately engaged in agriculture, was not a little singular. While the highest orders of society were driven into exile, or existed in terror, and while the inhabitants of the cities sustained the greatest hardships from the annihilation of all commerce, this terrible tempest past in a manner comparatively light and harmless over the heads of the obscure and scattered cultivators of the soil. In many quarters of the country their condition was even greatly and rapidly ameliorated. By the confiscation of the church lands, and of the estates of the emigrant nobles, the government for the time came to hold the property of a great part of the country. This government had too much business upon hand, to be able to levy correctly the rents of the property that had fallen into its possession; and for some time it had no occasion to do so, in consequence of the support which it derived from the issue of an immense paper currency. As this paper was a legal tender of payment in all transactions, and for all debts, those farmers who held their lands for payment of a money rent, took care to pay their landlords with paper, which they soon obtained at a cheap rate, while they themselves contrived to dispose of the produce of their farms for cash. Hence, a landlord, after the assignats had sunk in value, was often under the necessity of disposing of a part of his moveables to purchase from his own farmers a part of the grain which grew upon his own lands. In this way, by one means or other, a great proportion of the farmers in France found means during some

some years to avoid paying any rent whatever, and thus great numbers of them rose to sudden opulence, amidst the general calamities of their country. Many persons also perceiving the security of a country life, invested whatever money they had been able to save from the wrecks of other employments in agriculture, and became farmers or small proprietors. We have hitherto had too little connection with that country to be able to ascertain with accuracy, the effect of such a change of circumstances upon the practice of agriculture. It is understood, however, upon the whole, from inspecting the face of the country, that the agriculture of France is not conducted upon more enlightened principles than formerly: the general appearance of the soil still exhibits only white crops or fallow; the cattle are few; little manure therefore is prepared. Hence, the crop produced is always greatly inferior to what the land by more skilful arrangements might be made to bear.

Of the history of the agriculture of the rest of the continent of Europe we have little information, though some valuable practices made use of in particular situations will be afterwards noticed under their proper heads. In Germany, after the ruinous war of 30 years was brought to a termination by the treaty of Munster or Westphalia in 1648, agriculture was gradually diffused and improved in that vast country. In the Protestant states, at least, the art appears to be much better understood than in France. For many years it has been publicly taught in various universities, and during the last half of the late century great attention was paid to its improvement by many princes of the Empire. In Russia, vigorous exertions have repeatedly been made by the government to introduce, as far as possible into that climate,

History. climate, the most approved systems of husbandry, which have been established in other parts of Europe. The late empress sent several gentlemen into Britain and other countries to study agriculture, and gave it all the encouragement in her own dominions which the nature of her government, and the enslaved and barbarous state of the lower classes of her people, would permit. Even Italy, during the same period, was not inactive. The Neapolitans condescended to recur to the first rudiments of revived husbandry, and began to study anew the agricultural system of Crescenzi, first published in 1478. In Bergamo the same plan was pursued, and a new edition was given of the *Recordo d'Agriculturæ de Tarello*, first published in 1577. The patriotic society of Milan, exhibited specimens of ability, and enlightened information upon this important subject, which entitle it to a respectable place among the literary associations of Europe. The duchy of Tuscany, especially under the late Archduke Leopold, afterwards emperor of Germany, imbibed the same spirit of improvement. A private gentleman there, upwards of 40 years ago, left his whole fortune to endow an academy of Agriculture. The first ecclesiastic in the duchy was president of this society, and many of the chief nobility were members. But the events of the late war, by which Italy from the Alps to the gulf of Tarentum suffered so much, must undoubtedly for a time have injured the progress of agriculture, as well as of every other valuable art.

In the year 1759, a few ingenious and public-spirited men at Berne in Switzerland established a society for the advancement of agriculture and rural economics. In that society were many men of great weight in the republic, and most of them persons of a true cast for making

making improvements in husbandry, being enabled to History.
join the practice with the theory.

Nor must we here omit to mention, that the justly celebrated Linnæus and his disciples have made great efforts in the north of Europe, particularly in discovering new kinds of profitable and well-tasted food for cattle. About the same time, Sweden bestowed successful labours on a soil which had before been looked upon as cold, barren, and incapable of melioration. Of this the Stockholm Memoirs will be a lasting monument.

Denmark, and many of the courts of Germany, followed the same example. Woollen manufactures were encouraged; and his Danish majesty sent three persons into Arabia Felix to make remarks and bring over such plants and trees as would be useful in husbandry, building, and rural affairs.

Neither must we forget the very assiduous attention of the learned in Leipsic and Hanover to this important object. During the rage and devastation of a long war, they cultivated the arts of peace; witness the *Journal d'Agriculture* printed at Leipsic, and the *Recueils d'Hanover* printed in that city.

Even Spain, constitutionally and habitually inactive on such occasions, in spite of all her natural indolence, and the prejudices of bigotry, invited Linnæus, with the offer of a large pension, to superintend a college founded for the purpose of making new inquiries into the history of nature and the art of agriculture.

But, without any improper partiality to our own country, we are fully justified in asserting, that Britain alone exceeds all modern nations in husbandry;
and

History. and from the spirit which for the last twenty years has animated many of our nobility and gentry, to become the liberal patrons of improvement, there is reason to hope that this most useful of arts will, in a few years, be carried to a greater pitch of perfection than it has ever yet attained in any age or country.—The Royal Society, the Bath Society, and the Society of Arts, &c. in particular, have been signally useful in this respect; and the other associations, which are now established in many parts of the kingdom, co-operate with them in forwarding their laudable designs.

It is not, however, to the exertion of public societies, excellent and honourable as they are, that all our modern improvements in agriculture owe their origin. To the natural genius of the people, and the mildness and wisdom of the government, have been added the theory and practice of all nations in ancient and modern times. This accumulated mass of knowledge has been arranged, divided, and subdivided; and after passing the test of practical experiments, the essential and most valuable parts of it have been preserved, improved, and amply diffused in a variety of valuable publications upon this great art of rendering mankind happy, wealthy, and powerful, particularly in the works of Stillingfleet, Lord Kaines, Dr Hunter, Dr Anderson, Mr Marshall, Mr Kent, The Reverend Mr Dickson, and various others, but more especially in the compilations and treatises published by Arthur Young, Esq. already mentioned.

Board of
Agriculture.

We also remark with much satisfaction, that the British government has of late years thought fit to render the improvement of agriculture an object of public attention and encouragement, by the institution of a

board of agriculture.—About the year 1790, Sir John ^{History.} Sinclair, Bart. invited the clergy of the church of Scotland to transmit to him descriptions of the state of their different parishes, with a view to the publication of what is called a *Statistical Account of Scotland*. The whole members of this body having readily complied with his request, a work in 20 volumes octavo was compiled from the materials afforded by them, containing an account of the agriculture, manufactures, and population of the country. The same gentleman, about that period, was also active in obtaining the institution of a private society, called *The British Wool Society*, which was very successful in calling the attention of the public to the improvement of that important article of national growth and manufacture. By these patriotic exertions, having acquired a considerable share of popularity, he was encouraged on the 15th May 1793, to make a motion in the house of commons, of which he was a member, for an address to the crown, recommending the institution of a board of agriculture. The chancellor of the exchequer, Mr Pitt, on perceiving that the proposal was acceptable to the majority of the house, gave it a decided support, and on the 17th May, to which the debate had been adjourned, the motion was carried for an address to his majesty to institute such a board, at an expence not exceeding 3000l.—In consequence of this application, a charter passed the great seal, incorporating the members of administration for the time, with the archbishops of Canterbury and York, and all their successors in office, together with certain other noblemen and gentlemen, into a board or society, by the name of the *Board or Society for the encouragement of Agriculture and internal improvement*, under the patronage

History. tronage of the crown ; with power to the members to elect office-bearers and successors to themselves : and in the mean time Sir John Sinclair was appointed to be the first president, to continue in office till the 25th March following ; Sir John Caul, Bart. was appointed to be the first treasurer, and Arthur Young, Esq. was appointed secretary.

Commencement of its settings. The regular sittings of the board did not commence till 23d January 1794, since which time it has continued to exert a very considerable degree of activity in establishing an extensive foreign correspondence, and in procuring and publishing every kind of useful domestic agricultural intelligence, some specimens of which we shall afterwards have occasion to notice. This board, soon after its institution, also employed persons of known reputation to prepare agricultural surveys of every county in the island of Great Britain.—Many of these surveys have been published, and form treatises upon this important art, which, for extent of intelligence and ability of execution, have not been exceeded in any age or country. The board has also obtained parliamentary rewards to some individuals for important discoveries, and has offered premiums for essays or treatises upon subjects connected with the purpose of its institution, which have produced a great variety of valuable and ingenious disquisitions.

More particularly, in consequence of the late extraordinary dearth and scarcity of provisions, the legislature thought fit to have recourse to the assistance of the board for the purpose of endeavouring to alleviate the evil. In December 1800, a committee of the house of lords, with a view to extend the cultivation of grain, required the board to make out a report upon the best

means of converting grass lands into tillage without exhausting the soil, and of returning the same to grass after a certain period in an improved state, or at least without injury. The Board having taken the subject into consideration, resolved that the best mode of inducing landlords to permit grass lands to be ploughed, would be to convince them that they may do it in many cases, not only without injury, but also to their advantage. In consequence of this resolution, an advertisement was published by the Board, offering very liberal premiums for the most satisfactory essay upon the subject. This advertisement produced a great number of disquisitions or essays, the greater part of which were written by candidates for the premiums, but some of them were the productions of public-spirited gentlemen who made no such claim. From the whole number several essays have been selected and published by the Board, and form a very valuable volume, upon an interesting part of the most important of all subjects in the art of agriculture, the rotation or succession of different crops upon the same soil.

This affords an example of the utility of an institution acting, like the Board of Agriculture, under the sanction of the legislature. It enjoys the means of directing the attention of men of talents in all parts of the country, to any subject upon which practical information may be wanted; and it possesses the means of communicating to the public at large, in the most advantageous manner, whatever information may be obtained from the communications made to it. But although the diffusion of the knowledge of the principles of any art affords at all times the best means of its improvement, this undoubtedly is only a part of the duty

History. of such a public body as the Board of Agriculture. Public establishments and efforts are in many cases necessary towards carrying the art to its ultimate perfection. Means ought to be adopted in all the great seminaries of learning for rendering the knowledge of its principles a part of a liberal education. Obstacles to its progress, arising from tythes, rights of commonalty, &c. ought to be removed; and it may even be found advantageous to give public assistance towards the erection of works which may prove too expensive to be undertaken by individuals for the purposes of irrigation, in the same manner as has been done in other countries, as already mentioned. In these and all similar cases, it becomes the duty and the most valuable privilege of a board established by public authority to give counsel to the legislature, to suggest improvements, and to urge the expenditure of money upon public works, in cases where the advice of individuals might be disregarded, or listened to under the suspicion of its being prompted by views of private interest.

THEORY

THEORY

or

AGRICULTURE.

IN an art that is so necessary to mankind, and that General Remarks.
has been so universally practised, it might perhaps be expected, that the principles upon which its operations depend, would have been by this time completely and accurately investigated, and consequently that a The theory correct theory of agriculture could easily be exhibited. This, however, is by no means the case; and it is not defective. It is little singular, that, in this most useful of all arts, the theory should still be more defective than in almost any science with which we are acquainted. It is fortunate, however, for the human race, that in most cases, or at least in all important arts, they succeed better in practice than in speculation. During many ages, various artists were accustomed to extract the most ordinary, but most useful metals, from the state of ore or earth in which nature produces them, and to reduce them back from their metallic form and lustre, to a state of ore or earth again. These artists were unacquainted with the principles upon which the success of their operations depended; and it is only within these few years that some ingenious chemists have successfully investigated the nature of these processes, and have ex-

D 2 plained

General Remarks.—Explained what they have called the oxygenation and dis-oxygenation of metals. The same thing has happened in agriculture. Men have often cultivated the ground well, while they have speculated ill concerning the mode of doing so.

Difficulty of forming it. Various reasons render it still more difficult to form a complete theory of agriculture, than of chemistry, mechanics, or other arts. In agriculture, an experiment cannot be made in an instant, or even in an hour, or in a day or two. A whole season must pass away before a single experiment can be performed, and after all, as in other arts, the inquirer after truth may be misled by some unobserved circumstances. Some fact, quite foreign to the experiment itself, arising out of the peculiar state of the soil, or of the train of seasons, may produce plentiful crops for a year or two, though, in ordinary circumstances, no such effect would follow; and the ingenious contriver of the experiment, who thought he had made an important discovery, may afterwards derive from it only disappointment and mortification. But human life is too short to admit of a very great variety of agricultural experiments to be performed by the same individual. After a few seasons, he must leave his place to be occupied by a new inquirer, possessed of a different character and of different views. Unfortunately, till of late years, it was not usual for husbandmen to publish, and thus to immortalize and diffuse over whole nations, the result of their private experience and reflections. Scattered over the face of great countries, and having little intercourse with foreigners, or even with each other, they knew little of what was done by men engaged in the same profession, though at no great distance.—In this way, the benefit of

of local discoveries was not communicated to the world Division of the Subject. at large, nor was an opportunity afforded of eradicating local prejudices and erroneous practices. As the state of this valuable profession is now rapidly altering in these respects, there is little doubt that we are fast approaching towards a period at which it will be possible to exhibit a clear and correct theory of agriculture, or to arrange under a few simple heads the rules or principles upon which the practice of the art depends.— What we are now to offer, is not to be considered as perfect, nor even as possessing any nearer approximation towards a perfect theory of the husbandman's art; but merely, such a general statement of its principles as results from the degree of information hitherto collected upon the subject.

A theory, or general view of the principles of agriculture seems necessarily to resolve itself into the two ought to contain. following investigations: 1st, To inquire, among the great variety of vegetables that exist in nature, what particular plants ought to be regarded as most worthy of cultivation: and, 2dly, To consider the best mode of cultivating with success the plants thus selected.

With regard to the first of these divisions of the subject, or the vegetables that ought to be chosen as most valuable and worthy of cultivation, it may be observed, that the value of a plant is of two kinds, *absolute*, or *relative*: The *absolute* value of a plant depends upon its fitness to afford subsistence to the human species, whereas its *relative* value consists of the tendency which the cultivation of it will have to enrich a particular husbandman, or class of husbandmen, either because their lands are well adapted for its growth, or because there

Vegetables is a ready market for it in the vicinity, where it bears a ^{used by} high price.

They are useful directly and indirectly.

Concerning the absolute value of plants, or their tendency to afford subsistence to mankind, it is to be observed, that some plants are *directly* useful or valuable, because they are immediately consumed as food by man, such as wheat, oats, or potatoes; whereas mankind derive subsistence from another class of plants, only in an *indirect* manner, by giving them to cattle, and afterwards eating the flesh of these cattle, as happens with regard to grass and straw of all kinds.

SECT. I.

OF VEGETABLES TO BE CULTIVATED AS FOOD FOR MAN.

Men feed on fruits and roots.

SOME vegetables afford subsistence to the human species by means of the fruit that grows upon them, which hangs, and is brought to maturity in the air, at the summit of their stems. Other vegetables derive their value from producing roots, which come to maturity in the bosom of the soil, and are dug from thence to be consumed by mankind.

Fruit trees not trusted to for food,

Of fruit-bearing vegetables, those called *trees*, which rise aloft with a strong trunk, are the most permanent and remarkable. It is said that a spot of ground, occupied by some kinds of trees, such as chestnuts or dates, is capable of producing a very great portion of food, useful for the support of the human species. One advantage attending the cultivation of such vegetables, would be that, after the trees are planted, and secured by fences for a few years against animals, they would for ever

ever after, or at least for many years, continue to grow Vegetables and flourish without care or labour. It does not appear, however, that in any nation of ancient or modern times, forests of fruit-bearing trees have been reared with a view to afford subsistence to the community. For this two reasons may be assigned. In the first place, a considerable number of years must elapse, before such plants because could arrive at maturity, and fulfil the purpose of their destination. Of whatever use, therefore, they might be to future ages, it is evident that they could afford little benefit to the generation which planted them. But in a question about subsistence, mankind are usually under the necessity of considering their own immediate wants, and hence they have been led to the cultivation of such plants, as afford the most speedy reward for the efforts of their industry. Another reason for preferring the culture of small annual plants, to the greater and more permanent productions of nature, would arise, in the early ages of the world, from the turbulent state of society and the frequency of wars. A community that should depend for its subsistence upon the fruit of forest trees, might be ruined for half a century by the inroad of an enemy. An example of this was exhibited in the war between Great Britain and her North American colonies. When the parent state hired the savages on the western frontier, to join her party and to make inroads upon the colonists, the latter retaliated upon the savages in the following manner. Several of the colonies united in sending an expedition against the Indians. The bodies of militia employed upon this expedition, were surprised to find small corn fields around a considerable number of the Indian hamlets. They were not satisfied however with destroying the huts of the natives, and these incipient

Vegetable ent efforts of savage industry ; but they anxiously sought
~~wild by~~
out and destroyed every fruit-bearing tree that they
found in their progress of almost a thousand miles, thereby rendering the wilderness utterly uninhabitable to a people destitute of agriculture, and who could not always depend for subsistence upon their success in hunting. From this example we see that the frequent wars arising from the barbarous character of ancient nations, would compel them to seek subsistence, not from the fruit of forest trees, but from grain, which speedily arrives at maturity, and which when destroyed can soon be renewed. Thus war becomes a less wasteful scourge to the human race, and communities are enabled speedily to recover from the devastation which it produces. Had the nations of Europe depended for subsistence upon any fruits which could not be speedily restored when destroyed, it is evident, that, in the late sanguinary conflict, the greater number of them must have been irretrievably ruined.

~~Men rather trust to grain.~~ Hence it appears that the cultivation of plants of annual growth, as a source of subsistence, is favourable to the permanence of civilization in the world ; and that before nations can venture to rely for their subsistence upon the fruit of plants of slower growth, their character must have arrived at a degree of moral amelioration far superior to what it has ever been known to possess.

Of annual plants cultivated for fruit, wheat has always been accounted the most valuable. This has probably arisen from the extreme facility with which the flour of it undergoes a process of fermentation, which renders it capable of becoming a more light and agreeable kind of bread than the flour of any other grain.

This

This quality is believed to arise from a quantity of a ^{Vegetables used by} substance contained in wheat that is of the same nature ^{Man.} with the gluten, or glue, that is prepared from animal bodies. In other respects, however, it does not appear that wheat is more valuable than some other kinds of grain: by means of long boiling, a given weight of barley, or even of oats, will render a quantity of water as thick or full of mucilage as can be done by the same weight of wheat.

After wheat, oats have in our country been considered as of very great importance. It is a hardy and ^{Oats a valuable} grain. beautiful plant; grows with little cultivation, and is particularly well suited for lands newly brought in from a state of nature, upon which it was always used as the first crop, till the introduction of the turnip husbandry. The meal of it is usually very coarsely grinded, and mixed with a considerable quantity of the inner covering of the grain. Hence it has always a considerable degree of roughness, and is harsh and unsuited to very delicate constitutions; but this very harshness, from its stimulant effect, producing a feeling of warmth in the stomach, renders it more grateful to persons much exposed to the open air, and accustomed to hard labour, who account it a hearty kind of food. Essentially, and in its intrinsic qualities, this grain differs little from some others.

Barley is chiefly valued in consequence of the facility with which it produces a great quantity of saccharine matter by the process of vegetation or malting, which fits it for the preparation of vinous or spirituous liquors. Pease are also sometimes used when grinded into meal as an article of human food; but, on account of their viscid and indigestible quality, they can never become

Vegetables become valuable in that point of view, unless to persons engaged in the open air, in the most active and severe kinds of labour.

Different kinds of grain are not essentially different.

In other respects, however, it does not appear that there is much difference in point of quality or wholesomeness between the various kinds of grain cultivated in different countries. They are all capable of affording nourishment to the human constitution, and of preserving it in health and vigour: When grinded into meal, they require little farther preparation, and are easily made into bread, or otherwise prepared for immediate consumption, by being mixed according to the fancy or taste of different nations, with a small quantity of water, or any other liquid.

Roots used as human food.

Of the roots which are used to afford subsistence to man, the potato has hitherto been the principal. The rest, consisting chiefly of carrots, turnips, and parsnips, are never used as a sole nutriment, being rather adopted for the purpose of giving variety and relish to other food, and chiefly to butchers meat. The potato, however, is in some measure an exception to this general rule. It contains a large quantity of starch, which does not seem inferior to the starch prepared from wheat, so far at least as that ingredient is to be regarded as contributing to the nourishing qualities of the grain. Its taste resembles, more nearly than any other root, the taste of bread; and accordingly it is daily beginning to be more extensively used, and to form a larger portion of the food of the poor. The celebrated Dr Adam Smith long since remarked its tendency to produce a strong and handsome race of people, as demonstrated by its effect upon the common people of

Ireland,

Ireland, who have for a considerable length of time in Vegetables used by
a great measure subsisted upon it.

It is to be observed concerning all the roots now mentioned, that a crop of them always contains a much larger quantity of human food than a crop of any kind of grain, upon the same extent of ground. A Scots acre of good land, which will not produce more than grain,

1280 pounds weight of oatmeal, will easily produce 16,000 pounds weight of potatoes, and will sometimes in favourable seasons produce 25,000 or 30,000 pounds weight of that valuable root. Supposing one pound of oatmeal to contain as much nourishment as two pounds and a half of potatoes, still it is evident, that, where an extent of territory employed in the production of oats can only support one million of people, the same territory employed in the cultivation of potatoes will support five millions of persons.

Potatoes, however, and all the other roots, have hitherto possessed these radical defects: The carriage of them is extremely expensive, in consequence of their weight, arising from the vast quantity of moisture they contain. Hence they can only be cultivated in abundance in the vicinity of great towns, or where they are meant to be consumed upon the farm as the food of cattle.

Roots are also incapable of long preservation. In the winter they are destroyed by frost, and in summer by heat, which causes them to vegetate or to corrupt; both of which changes render them unfit to be used as food.

These roots are also much more bulky than grain in proportion to the quantity of nourishment contained in them. Hence they are rendered less fit to be consumed

Too bulky
for the stor-
age

med

Vegetables used by persons engaged in sedentary professions.
 used by
 Man. Such persons accordingly seldom fail to find them hurtful to the stomach, by their bulkiness, and their tendency to injure the powers of digestion, by producing flatulencies and other unpleasant consequences.

Wherein they differ from grain.

On the whole, the difference between these succulent roots and the grain of corn plants seems to amount to this, that, although they are both formed of similar substances, the potato being analogous to wheat, and the carrot and parsnip to rye, or rather to barley, after it has been converted into malt, yet, as the roots are formed in the bosom of the soil, and are of a loose and watery texture, their formation requires from nature a slighter effort than the bringing to perfection the small grains which are produced in the air at the top of corn plants. She therefore compensates, by an abundant crop, the diminished quality of her work.

How they may be rendered equal in value to grain.

Potato.
Hence.

Grenet,
mode of
preserving
potatoes.

Hence it has appeared an important problem in economics, to devise a plan by which the succulent roots of vegetables may be deprived of their superfluous moisture, that thus human art may perform for them what nature has not accomplished; and that they may be rendered completely equal in value to grain in point of quality, while in quantity they are so superior. With this view different processes have been adopted. Potatoes have been grated down in their raw state, and repeatedly washed with water; the result of which operation is, that the starch contained in them is obtained with great labour, but the rest of the root is lost; and this operation cannot be applied to other kinds of roots with success. Another mode of accomplishing the object was devised a few years ago by M. Grenet, and published in the Journal of the Lyceum of Arts

of

of Paris. It is performed in this manner: The potatoes must first be boiled by the heat of the steam of boiling water, without touching the water itself. They are then stript of their skin, and allowed to cool, and made use of in the following way:—A white-iron tube of two inches diameter, and eight inches in length, open at the one end and close at the other, is every-where perforated with small holes, and a round piece of wood is prepared, which easily goes into the tube, but which at the same time fills it. Things being thus in readiness, a quantity of the potatoes, boiled as already mentioned, is put into the tube till it is full. They are then forcibly rammed down with the round piece of wood or piston; the consequence of which operation is, that they are forced through the little holes in the sides of the tube, and come out in the shape of worms. They are received upon linen cloths, covered with unsized paper, and dried in the heat of the sun, or in a warm room. The small pieces must be stirred from time to time; and it is said, that in less than 12 hours, the preparation dries so as to be capable of being preserved.

The defect of this process evidently is, that it is a petty operation, which can only proceed slowly, and upon a diminutive scale. It is therefore unlikely to be adopted in the great operations of an extensive agriculture, as a mode of preparing or preserving human food.

At the beginning of the year 1802, another process for accomplishing this important object was contrived by Robert Forsyth, Esq. advocate. Of this process, we are authorized to give the following account:

The

~~Vegetables
sized by
Man.~~ The whole difficulty of discovering a process, with
the view to render succulent roots as easily preserved
and transported, and therefore in every respect as va-
luable as grain, arises from our not having the com-
mand of such a degree of steady and vigorous, but
moderate heat, as will deprive them of their moisture,
while at the same time they are prevented from being
burnt or scorched in the way that coffee-beans are
treated before being grinded. This requisite degree
of heat may be obtained in a very cheap and easy man-
ner, by making use of the steam of boiling water,
which never can burn any vegetable substance. Upon
this principle, Mr Forsyth's process is founded, and is
conducted in the following manner :

1st, Let a quantity of potatoes, or carrots, or par-
snips, &c. be washed, and then cut or chopped into
very small pieces.

2dly, Lay them upon a metallic plate, and dry
them with the heat of steam transmitted through the
metal. They are then in a state analogous to grain,
and seem capable of being preserved for any length of
time.

3dly, Reduce them into flour or meal, by grinding
in any mill, or with any instrument capable of grind-
ing grain.

The meal or flour thus prepared has no tendency to
attract moisture from the atmosphere, and may be pre-
served during any length of time, if closely pressed or
packed. Without this precaution, Mr Forsyth has
preserved it for twelve months, when it had been
coarsely grinded in a coffee-mill.

The drying process is not tedious. As potatoes
contain a great quantity of starch or gummy matter,

the pieces of them, while drying, are apt to adhere to Vegetables used by each other; they must therefore be frequently turned Man. or stirred during that part of the operation. When dry, they are almost as hard as barley, and taste somewhat like the skin of a roasted potato.

Carrots and parsnips contain less gummy matter. They require less attention while drying, and do not become so hard. They may be grinded with ease. Their flour is very sweet to the taste. Its smell is fragrant, and though the taste of the roots cannot be said to be altered, it is rendered rich and agreeable by the concentration produced by the process. This is more particularly the case with regard to the parsnips. Their meal, when coarsely grinded, and exposed to the air for a month or two, loses its grateful smell, but the taste continues unchanged. The taste is communicated very rapidly to lukewarm water, by pouring it upon the meal, so that it may probably prove of some value when subjected to the vinous fermentation; and it seems not improbable, that if sugar is ever to be produced in abundance from plants of European growth, it must be by preparing them according to this process.

Mr Forsyth performed his experiments with a steam apparatus, which, with some alterations, may prove not unsuitable, when erected upon a great scale.

A, Plate XIII. fig. 5. a shallow vessel of tinned plate, Mr Forsyth's steam commonly called *white iron*, one foot square, and two inches in depth, for containing substances to be dried.

B, a small round vessel, in which water is kept boiling by a lamp, C, with three wicks.

D, a tube, by which the steam passes into E, which contains

Vegetables ^{used by} contains the drying vessel A, and is closely soldered all round to the bottom of it.

F, a tube, by which the water formed by the condensed steam, flows from the steam vessel, E, back into the boiler B, entering at the bottom of the boiler.

G, a crooked tube, by which the superfluous steam escapes into the open air. It is crooked, that it may retard the passage of the steam when the vessel is at work, which forces it to deposit more of its heat on the bottom of the drying vessel A.

H, a tube by which the boiler B is filled with hot water.

I, a tube passing up through the centre of the boiler, and serving as a chimney to the lamp C. It does not communicate with the water in the boiler.

K shews the figure of the cover of the drying vessel A. The cover has a groove or gutter LL, passing round its lower edge. The vapour which rises from the roots when drying, condenses on touching the cover, and flows down to the gutter, from which it escapes in the state of water, by a hole left for that purpose at each corner. The cover is only used for the neatness requisite in making experiments.

The whole is supported by four moveable feet, attached to the corners of the drying vessel A, but not appearing in the figure. Every part of it is made of white iron or tinned plate.

Instead of the lamp C, a small iron pan filled with pieces of burning charcoal, was sometimes used to keep the water boiling, and a still more convenient plan was at times adopted during the winter season. It consisted of resting the bottom of the boiler B, upon

the front of the grate of the chamber, while a fire was burning, the rest of the instrument being at the same time supported by a rope attached to the back of a chair, to a nail or peg in the wall for hanging a picture, or to any other convenient support. When used in this last manner, however, the instrument has this defect, that the water in the tube H boils over at times into the fire, which might be avoided, by placing the tube on the opposite side of the boiler.

Upon the above contrivance it may be remarked, that a kiln formed of a large metallic plate, heated by the steam of boiling water, may prove valuable in many processes. In particular, it will probably be found useful for drying malt, with a view to prevent the ale formed of it from having a brown colour. It may also, perhaps, be used with success for drying wheat that is intended to be sown, to prevent the future crop from suffering by mildew, as will be afterwards mentioned; and it affords a ready and cheap mode of drying not only roots, but all vegetable productions, without burning them, or altering their taste or other essential properties.

SECT. II.



OF THE MOST PROPER KINDS OF VEGETABLES TO BE RAISED FOR THE PURPOSES OF FEEDING CATTLE.

THOUGH this must be an article of the utmost consequence to every farmer, we do not find that it has been much considered. Dr Anderson seems to have been the first writer on agriculture who has properly attended to this subject; and what he has wrote upon

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it,

~~Vegetable~~ it, is rather a catalogue of desiderata, than any thing food for Cattle. else: and indeed the desiderata on this subject are so many and so great, that we must acknowledge ourselves very unable to fill them up.—To attain to a competent knowledge in this respect, the following things Qualities must be taken into consideration. (1.) The wholesomeness of the food for cattle, with regard to health and strength, or fatness. (2.) The quantity that any extent of ground is capable of yielding. (3.) The quantity necessary to feed the different kinds of cattle. (4.) The labour of cultivation; and, (5.) The soil they require to bring them to perfection, and the effect they have upon it.

Cabbages,
their pro-
perties.

With regard to the wholesomeness, it is plain, that as the natural food of wild cattle is the green succulent plants they meet with all the year round, food of this kind, could it be had, must be preferable to hay; and accordingly we find that cattle will always prefer succulent vegetables where they can get them. To find plants of this kind, and having proper qualities in other respects, we must search among those which continue green all the year round, or come to their greatest perfection in the winter time.—Of these, cabbages bid fair for holding the first place; both as being very succulent, and a very large quantity of them growing upon a small space of ground. In Mr Young's Six Months Tour, we have an account of the produce of cabbages in many different places, and on a variety of soils. The produce by Mr Crow at Keplin, on a clay soil, was, on an average of six years, 35 tons per acre; by Mr Smeat at the Leafes, on a sandy gravel, 18 tons per acre; by Mr Scroop at Danby, on an average of six years, 37 tons per acre: and the general average of

of all the accounts given by Mr Young, is 36 tons per acre.

Vegetables
food for
Cattle.

Cabbages, however, have the great inconveniency of sometimes imparting a disagreeable flavour to the milk of cows fed with them, and even to the flesh of other cattle. This, it is said, may be prevented by carefully picking off the decayed and withered leaves : and very probably this is the case ; for no vegetable inclines more to putrefaction than this ; and therefore particular care ought to be taken to pull off all the leaves that have any symptoms of decay. Dr Priestley Air rendered noxious by them found that air was rendered noxious by a cabbage leaf remaining in it for one night, though the leaf did not shew any symptom of putrefaction.—For milch cows, probably, the cabbages might be rendered more proper food by boiling them.

The culture of the turnip-rooted cabbage has lately been much practised, and greatly recommended, particularly for the purpose of a late spring feed ; and seems indeed to be a most important article in the farming economy, as will be shown in its proper place.

Turnips likewise produce very bulky crops, though far inferior to those of cabbages. According to Mr Young's calculations, the finest soil does not produce above five tons of turnips per acre. In this respect, however, great varieties occur, as will be afterwards mentioned ; and turnips possess the advantage of flourishing upon a poorer soil than cabbages.

Carrots are found to be an excellent food for cattle of all kinds, and are greatly relished by them. In a rich sand, according to Mr Young's account, the produce of this root was 200 bushels per acre. In a finer

Vegetables soil, it was 640 bushels per acre. A lean hog was fat-
^{food for}
~~cattle.~~ fed by carrots in ten days time: he ate 196 lb.; and
his fat was very fine, white, firm, and did not boil away in the dressing. They were preferred to turnips by the cattle; which, having tasted the carrots, soon became so fond of them, as with difficulty to be made to eat the turnips at all. It is probable, indeed, that carrots will make a more wholesome food for cattle than either cabbages or turnips, as they are strongly antiseptic; insomuch as to be used in poultices for correcting the sanies of ulcers. It is probably owing to this, that the milk of cows fed on carrots is never found to have any bad taste. Six horses kept on them through the winter, without oats, performed their work as usual, and looked equally well. This may be looked upon as a proof of their salubrity as a food; and it certainly can be no detriment to a farmer to be so much versant in medical matters, as to know the impropriety of giving putrescent food to his cattle. It is well known what a prodigious difference there is in the health of the human species when fed on putrid meats, in comparison of what they enjoy when supplied with food of a contrary nature; and why may there not be a difference in the health of beasts, as well as of men, when in similar circumstances?—It is also very probable, that as carrots are more solid than cabbages or turnips, they will go much farther in feeding cattle than either of them. The above-mentioned example of the hog seems some kind of confirmation of this: he being fed, for ten days together, with 21lb. less weight of carrots, than what an ox devoured of cabbages and hay in one day. There is a great disproportion, it must be owned, between the bulk of an ox and that of a hog; but we can scarce think

think that an ox will eat as much at a time as ten hogs. Vegetables food for Cattle.
At Parlington in Yorkshire, 20 work horses, four bullocks, and six milch cows, were fed on the carrots that grew on three acres, from the end of September till the beginning of May; and the animals never tasted any other food but a little hay. The milk was excellent, and 30 hogs were fattened upon what was left by the cattle.

Potatoes likewise appear to be a very palatable food for all kinds of cattle; and not only oxen, hogs, &c. are easily fed by means of them, but even poultry. According to a correspondent of the Bath Society *, "roasting pork is never so moist and delicate as when fed with potatoes, and killed from the barn doors without any confinement. For bacon and hams, two bushels of pea-meal should be well incorporated with four bushels of boiled potatoes, which quantity will fat a hog of twelve stone (fourteen pounds to the stone). Cows are particularly fond of them: half a bushel at night, and the same proportion in the morning, with a small quantity of hay, is sufficient to keep three cows in full milk; they will yield as much and as sweet butter as the best grass. In fattening cattle, I allow them all they will eat: a beast of about 35 stone will require a bushel per day, but will fatten one-third sooner than on turnips. The potatoes should be clean washed, and not given until they are dry. They do not require boiling for any purpose but fattening hogs for bacon, or poultry; the latter eat them greedily. I prefer the champion potato to any sort I ever cultivated. They do not answer so well for horses

* *Letters and Papers on Agriculture, &c.* vol. iii. art. 16.

Vegetables and colts as I expected (at least they have not with me),
food for cattle. though some other gentlemen have approved of them as
substitutes for oats."

The above-mentioned vegetables have all of them the property of pulverizing or softening the soil; and this is certainly a very valuable qualification: but carrots and cabbages will not thrive except in soils that are already well cultivated; while potatoes and turnips may be used as the first crops of a soil with great advantage. In this respect, they are greatly superior to the others, on account of the encouragement which they give to the cultivation of waste lands.

Buck-wheat (*Polygonum fagopyrum*) has been lately recommended as an useful article in the present as well as other respects. It has been chiefly applied to the feeding of hogs, and esteemed equal in value to barley; it is much more easily ground than barley, as a malt-mill will grind it completely. Horses are very fond of the grain; poultry of all sorts are speedily fattened by it; and the blossom of the plant affords food for bees at a very opportune season of the year, when the meadows and trees are mostly stripped of their flowers. Probably the grain may hereafter be even found a material article in distillation, should a sufficient quantity be raised with that view. From the success of some experiments detailed in the Bath Society Papers, and for which a premium was bestowed, it has been inferred, that this article ought in numerous cases to supersede the practice of summer-fallowing.

Whins an excellent food for horses.

Whins have lately been recommended as very proper food for cattle, especially horses; and are recommended by Dr Anderson in a particular manner. They have this advantage, that they require no culture, and grow

grow on the very worst soil; but they are troublesome to cut, and require to be bruised in a mill constructed for this purpose; neither is the ground at all meliorated by letting whins grow upon it for any length of time. Notwithstanding these disadvantages, however, as whins continue green all the year round, and when bruised will afford an excellent succulent food, which seems possessed of strongly invigorating qualities, they may be looked upon as the cheapest winter food that can possibly be given to cattle.—According to the calculations of Mr Eddison of Gateford, a single acre, well cropped with whins, will winter six horses. At three or four years growth, the whole crop should be taken, cut close to the ground, and carried to the mill, in which the whins are to be bruised, and then given to the horses. Four acres ought to be planted, that one may be used each year, at the proper age to be cut; and he reckons the labour of one man sufficient for providing food to this number of horses. He says they all prefer the whins to hay, or even to corn.

The herb called *burnet* has likewise been recommended as proper food for cattle, on account of its being an evergreen; and further recommended, by growing almost as fast in winter as in summer. Of this herb, however, we have very various accounts. In a letter addressed by Sir James Caldwell, F. R. S. to the Dublin Society, the culture of this plant is strongly recommended, on the authority of one Bartholomew Rocque, farmer at Walham-Green, a village about three miles south-west of London.

What gave occasion to the recommendation of this plant, was, that about the year 1760, Mr Wych, chairman of the committee of Agriculture of the London

Vegetables
food for
Cattle.

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^{recommended by}
Sir James
Caldwell.

Vegetables Society for the encouragement of arts, manufactures, food for Cattle. and commerce, came to Rocque (who was become very eminent by the premiums he had received from the society), and told him, he had been thinking, that as there are many animals which subsist wholly upon the fruits of the earth, there must certainly be some plant or herb fit for them that naturally vegetates in winter; otherwise we must believe the Creator, infinitely wise and good, to have made creatures without providing for their subsistence; and that if there had been no such plants or herbs, many species of animals would have perished before we took them out of the hands of nature, and provided for them dry meat at a season, when, indigenous plants having been indiscriminately excluded, under the name of weeds, from cultivated fields and places set apart for natural grass, green or fresh meat was no longer to be found.

Rocque allowed the force of this reasoning; but said, the knowledge of a grass, or artificial pasture, that would vegetate in winter, and produce green fodder for cattle, was lost; at least, that he knew of no such plant.—Mr Wych, however, knowing how very great the advantage would be of discovering a green fodder for winter and early in the spring, wrote to Bern, and also to some considerable places in Sweden, stating the same argument, and asking the same question. His answers to these letters were the same that had been given by Rocque. They owned there must be such plant, but declared they did not know it.

Mr Wych then applied again to Rocque; and desired him to search for the plant so much desired, and so certainly existing. Rocque set about this search with great assiduity; and finding that a pimpernel, called

called *burnet*, was of very speedy growth, and grew Vegetables
food for
Cattle. nearly as fast in winter as in summer, he took a handful of it and carried it into his stable, where there were five horses; every one of which ate of it with the greatest eagerness, snatching it even without first smelling it. Upon the success of this experiment he went to London, and bought all the burnet seed he could get, amounting to no more than eight pounds, it having been only used in salads; and he paid for it at the rate of 4s. a-pound. Six of the eight pounds of seed he sowed upon half an acre of ground, in March, in the year 1761, with a quarter of a peck of spring wheat, both by hand. The seed being very bad, it came up but thin. However, he sowed the other two pounds in the beginning of June, upon about six roods of ground: this he mowed in the beginning of August; and at Michaelmas he planted off the plants on about 20 rood of ground, giving each plant a foot every way, and taking care not to bury the heart. These plants bore two crops of seed the year following; the first about the middle of June, the second about the middle of September; but the June crop was the best. The year after, it grew very rank and produced two crops of seed, both very good. As it ought not to be cut after September, he let it stand till the next year; when it sheltered itself, and grew very well during all the winter, except when there was a hard frost; and even during the frost it continued green, though it was not perceived to grow. In the March following it covered the ground very well, and was fit to receive cattle.

If the winter is not remarkably severe, the burnet, though cut in September, will be 18 inches long in March;

~~Vegetables~~ ~~March~~; and it may be fed from the beginning of Fe-
~~Food for~~
~~Cattle.~~ bruary till May: if the cattle are taken off in May,
there will be a good crop of seed in the beginning of July. Five weeks after the cattle are taken off, it may be removed, if that is preferred to its standing for seed. It grows at the rate of an inch a-day, and is made into hay like other grass. It may be mown three times in one summer, and should be cut just before it begins to flower. Six rood of ground has produced 1150 pounds at the first cutting of the third year after it was sowed; and, in autumn 1763, Rocque sold no less than 300 bushels of the feed.

According to Rocque, the soil in which burnet flourishes best, is a dry gravel; the longest drought never hurts it: and Sir James Caldwell asserts, that he saw a very vigorous and exuberant plant of this kind, growing from between two bricks in a wall in Rocque's ground, without any communication with the soil; for he had cut away all the fibres of the root that had stretched downward, and penetrated the earth, long before.

Burnet was found equally fit for feeding cows, sheep, and horses; but the sheep must not be suffered to crop it too close. Though no feed was left among the hay, yet it proved nourishing food; and Rocque kept a horse upon nothing else, who, at the time of writing the account, was in good heart, and looked well. He affirmed also, that it cured horses of the distemper called the *grease*, and that by its means he cured one which was thought incurable; but says, it is only the first crop which has this effect.

Burnet rec-
roned an
improper
food by Mr
Miller and
Mr Ander-
son.

This is the substance of Sir James Caldwell's letter to the Dublin Society, at least as to what regards the culture of burnet; and it might reasonably be expect,

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ed, that a plant, whose use was recommended to the public with so much parade, would soon have come into universal esteem. We were surprised, therefore, on looking into Mr Miller's Dictionary, to find the following words, under the article *Poterium* :—“ This plant has of late been recommended by persons of little skill, to be sown as a winter pabulum for cattle: but whoever will give themselves the trouble to examine the grounds where it naturally grows will find the plants left uneaten by the cattle, when the grass about them has been cropped to the roots; besides, in wet winters, and in strong land, the plants are of short duration, and therefore very unfit for that purpose; nor is the produce sufficient to tempt any person of skill to engage in its culture; therefore I wish those persons to make trial of it in small quantities, before they embark largely in these new schemes.”—Dr Anderson, too, in his Essays on Agriculture, mentions the produce of burnet being so small, as not to be worth cultivating.

Upon the authority of Mr Rocque, likewise, the white beet is recommended as a most excellent food for cows; that it vegetates during the whole winter, consequently is very forward in the spring; and that the most profitable way of feeding cows is to mow this herb, and give it to them green all the summer. It grew in Rocque's garden, during a very great drought, no less than four feet high, from the 30th of May to the 3d of July; which is no more than one month and four days. In summer it grows more than an inch a-day; and is best sown in March: a bushel is enough for an acre, and will not cost more than ten shillings. It thrives best in a rich, deep, light soil: the stalks

are

Vegetables are very thick and succulent; the cows should therefore food for Cattle, eat them green.

Root of Scarcity. Another species of beet (*Beta cicla*), the Mangold Wurzel, or *Root of Scarcity*, as it has been called, has been lately extolled as food both for man and cattle; but, after all, seems only to deserve attention in the latter view. It is a biennial plant; the root is large and fleshy, sometimes a foot in diameter. It rises above the ground several inches, is thickest at the top, tapering gradually downward. The roots are of various colours, white, yellow, and red; but these last are always of a much paler colour than beetroot. It is good fodder for cows, and does not communicate any taste to the milk. It produces great abundance of leaves in summer, which may be cut three or four times without injuring the plant. The leaves are more palatable to cattle than most other garden plants, and are found to be very wholesome. The farmers in those parts of Germany where it is chiefly cultivated, we are told, prefer this species of beet, for feeding cattle, to cabbages, principally because they are not so liable to be hurt by worms or insects; but they think they are not so nourishing as turnips, potatoes, or carrots, and that cattle are not nearly so soon fattened by this root as by carrots, parsnips, or cabbages. It has even been asserted, that this root affords less nourishment than any of those that have been commonly employed for feeding cattle. This does not correspond with the pompous accounts with which the public has been entertained. Upon the whole, however, it is a plant which seems to deserve the attention of our farmers; as on some soils, and in particular circumstances, it may prove a very useful article for the above purposes.

In Dr Anderson's Essays, we find it recommended to make trial of some kinds of grasses, which probably would not only answer for fresh fodder during the winter, but might also be cut for hay in summer. This case is particularly the case with that species called *Sheep's fescue grass*. "I had," says he, "a small patch of this grass in winter 1773; which, having been cut in the month of August or September preceding, was saved from that period, and had advanced before winter to the length of five or six inches; forming the closest pile that could be imagined. And although we had about six weeks of very intense frost, with snow, and about other six weeks, immediately succeeding that, of exceeding keen frost every night, with frequent thaws in the day time, without any snow, during which time almost every green thing was destroyed; yet this little patch continued all along to retain as fine a verdure as any meadow in the month of May; hardly a point of a leaf having been withered by the uncommon severity of the weather. And as this grass begins to vegetate very early in the spring, I leave the reader to judge what might be the value of a field of grass of this kind in these circumstances."

Of another kind of grass, called *purple fescue*, Dr Anderson gives the following character: "It retained its verdure much better than rye-grass during the winter season; but it had more of its points killed by the weather than the former. It likewise rises in the spring, at least as early as rye-grass."

This ingenious farmer, and well-known author, has also made experiments on the culture of these and several other kinds of grasses.

In every branch of science actual experiment is the only

Vegetables only means by which any real or permanent improvement can be made. It is in consequence of a conviction of this truth, and of the active industry which has resulted from that conviction, that physical science has made such rapid improvements in modern times. Every experiment in the art of agriculture, when made with rational views, and reported with candour, is entitled to an uncommon degree of attention. It is not only, as in other branches of science, the only mode in which knowledge or improvement can be successfully pursued, but the person who engages in it usually possesses more merit than the contriver of other physical experiments, on account of the patient observation which he is under the necessity of exerting, in consequence of the length of time which must elapse before his trials can be rendered complete. The importance of the subject also entitles it to particular regard. We have every reason to believe that valuable plants will still be discovered, the use of which will give additional fertility to the earth, and additional resources for the support of the animals by which it is inhabited. It is certain at least that the person who introduced into any country the use of the turnip or potato plant, performed a more valuable service to its inhabitants, than if he had realized for them the imaginary art of the transmutation of all the metals into gold. We account it unnecessary, therefore, to make any apology for inserting here Dr Anderson's experiments upon several kinds of our native grasses, as, in another part of our work, we shall have occasion to state other experiments upon the same subject, which have been made by intelligent cultivators.

1. *Purple fescue grass.* "Although this grass is very often found in old pastures, yet, as it has but few flower-

stalks, and as it is greedily eaten by all domestic animals, these are seldom suffered to appear; so that it usually remains there unperceived. But it seems to be better able to endure the peculiar acrimony of the dung of dogs than almost any other plant; and is, therefore, often to be met with in *dog-hills*, as I call the little hills by road sides where dogs usually piss and dung: and as it is allowed to grow there undisturbed, the farmer may have an opportunity of examining the plant, and becoming acquainted with its appearance.

" The leaves are long and small, and appear to be roundish, something like a wire; but, upon examination, they are found not to be tubulated like a reed or rush; the sides of the leaf being only folded together from the middle rib, exactly like the strong bent-grass on the sea shore. The flower-stalk is small, and branches out in the head, a little resembling the wild oat; only the grains are much smaller, and the ear does not spread full open, but lies bending a little to one side. The stalks are often spotted with reddish freckles, and the tops of the roots are usually tinged with the same colour; from whence it has probably obtained its distinctive name of *festuca rubra*, or *red (purple) fescue*.

" It is often to be met with in old garden walks; and, as its leaves advance very quickly after cutting, it may usually be discovered above the other grasses, about a week or a fortnight after the walks are cut. Nor do they seem to advance only at one season, and then stop and decay, like the rye-grass; but continue to advance during the whole of the summer, even where they are not cut; so that they sometimes attain

Vegetables attain a very great length. Last season (1774), I measured a leaf of this grass, that sprung up in a neglected corner, which was four feet and four inches in length, although not thicker than a small wire. It is unnecessary to add, that these leaves naturally trail upon the ground, unless where they meet with some accidental support; and, that if any quantity of it is suffered to grow for a whole season, without being eaten down or cut, the roots of the leaves are almost rotted, by the overshadowing of the tops of the other leaves, before the end of the season.

Appearance in its cultivated state.

" This is the appearance and condition of the plant in its native situation: as it is seldom that it is discovered but in pretty old pastures, and, as in that state it carries only a very few seed-stalks, it was with some difficulty that I could collect a small handful of the seed, which I carefully sowed in a small patch of garden mould, to try if it could be easily cultivated. It came up as quickly as any other kind of grass, but was at first as small as hairs; the leaves, however, advanced apace; and were, before autumn, when the grain with which they had been sowed was cut down, about 16 or 18 inches in length; but having been sown very thin, it was necessary to pick out some other kinds of grass that came up amongst it, lest it might have been choked by them. Early the next spring it advanced with prodigious vigour, and the tufts that were formed from every seed became exceeding large; so that it quickly filled the whole ground. But now the leaves were almost as broad as those of common rye-grass, and the two sides only inclined a little towards one another from the mid-rib, without any appearance of roundness. In due time a great many seed-stalks sprung out, which

attained very nearly to the height of four feet, and produced seeds in abundance; which may be as easily saved as those of common rye-grass.

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“ The prodigious difference between this plant in its native and cultivated state amazed me; but it was with a good deal of satisfaction that I found there would be no difficulty in procuring seeds from it, which I had much doubted of at first. It would seem, that nature hath endowed this plant with a strong generative power, during its youth, which it gradually loses as it advances in age (for the difference perceived in this case could not be attributed to the richness of the soil); and that, on the contrary, when it was old, the leaves advanced with an additional vigour, in proportion to the declining strength of the flower-stalks: for the leaves of the young plants seldom exceed two feet, whereas numbers of the old leaves were near four feet in length.

“ From these peculiarities in the growth of this plant, it would seem to promise to be of great use to the farmer; as he could reap from a field of it, for the first two or three years, as great a weight of hay as he could obtain from any of the culmiferous grasses (those bearing a long jointed stalk); and, if he meant afterwards to pasture it, he would suffer no inconveniences from the flower-stalks; and the succulent leaves that continue to vegetate during the whole summer, would at all times furnish his cattle with abundance of wholesome food. It has also been remarked, that this grass rises as early in the spring as rye-grass; and continues green for the greatest part of winter, which the other does not. It is moreover an abiding plant, as it seems never to wear out of the ground where it has once

Vegetables been established. On all which accounts, it appears food for Cattle. to me highly to merit the attention of the farmer; and well deserves to have its several qualities, and the culture that best agrees with it, ascertained by accurate experiments.

Sheep's fescue described. 2. "Sheep's fescue grass, or *festuca ovina*, is much praised by the Swedish naturalists for its singular value as a pasture-grass for sheep; this animal being represented as fonder of it than of any other grass, and fattening upon it more quickly than on any other kind of food whatever. And indeed, the general appearance of the plant, and its peculiar manner of growth, seem very much to favour the accounts that have been given us of it.

"This plant is of the same family with the former, and agrees with it in several respects; although they may be easily distinguished from one another. Its leaves, like the former, in its natural state, are always rounded, but much smaller; being little bigger than large horse hairs, or swine-bristles, and seldom exceed six or seven inches in length. But these spring out of the root in tufts, so close upon one another, that they resemble, in this respect, a close hair brush more than any thing else I know: so that it would seem naturally adapted to form that thick short pile of grass in which sheep are known chiefly to delight. Its flower-stalks are numerous, and sometimes attain the height of two feet; but are more usually about 12 or 15 inches high.

Its appearance when cultivated. "Upon gathering the seeds of this plant, and sowing them as the former, it was found that they sprung up as quickly as any other kind of grass; but the leaves are at first no bigger than a human hair. From each

side

side springs up one or two of these hair-like filaments, Vegetables
that, in a short time, sends out new offsets, so as quickly-
ly to form a sort of tuft, which grows larger and larger,
till it at length attains a very large size, or till all the
intervals are closed up, and then it forms the closest pile
of grass that it is possible to imagine. In April and
May it pushed forth an innumerable quantity of flower-
stalks, that afforded an immense quantity of hay; it
being so close throughout, that the scythe could scarce-
ly penetrate it. This was allowed to stand till the
seeds ripened; but the bottoms of the stalks were quite
blanched, and almost rotted for want of air before that
time.

“ This was the appearance that it made the first year after it was sowed: but I have reason to think, that, after a few years, it likewise produces fewer seed-stalks, and a greater quantity of leaves, than at first. But, however that may be, it is certain, that if these are eaten down in the spring, it does not, like rye-grass, persist in a continued tendency to run to seed; but is at once determined to push forth a quantity of leaves without almost any stalks at all: and, as all domestic animals, but more especially sheep, are extremely fond of this grass, if they have liberty to pasture where it grows, they bite it so close as never to suffer almost a single seed-stalk to escape them; so that the botanist will often search in vain for it, when he is treading upon it with his feet. The best way to discover it in any pasture, is to search for it in winter, when the tufts of it may be easily distinguished from every other kind of grass, by their extraordinary closeness, and the deep green colour of the leaves.

“ It seems to grow in almost any soil; although it is ^{What soil} _{most pro-} imagined per.

~~Vegetables~~ ^{food for} they ought to be ; but which Dr Anderson, at the time of writing his treatise, thought most likely to be of value. It is probable his recommendation has contributed not a little to procure attention to several of them ; as it will afterwards appear, when we come to consider the culture of grasses, that they are now commonly sown by the best agriculturists. Besides these he recommends the following of the pea tribe.

Milk-vetch

1. *Milk-vetch*, *liquorice-vetch*, or *milk-wort*. This plant, in some respects, very much resembles the common white clover : from the top of the root a great number of shoots come out in the spring, spreading along the surface of the ground every way around it ; from which arise a great many clusters of bright yellow flowers, exactly resembling those of the common broom. These are succeeded by hard round pods, filled with small kidney-shaped seeds. From a supposed resemblance of a cluster of these pods to the fingers of an open hand, the plant has been sometimes called *hand-fingers*. By others it is called *crow-toes*, from a fancied resemblance of the pods to the toes of a bird. Others, from the appearance of the blossom, and the part where the plant is found, have called it *feal*, improperly *feath*, &c. It is found plentifully almost everywhere in old grass fields ; but as every species of domestic animal eat it almost in preference to any other plant, it is now done allowed to come to the flower in pasture ground, which where they have been accidentally sown on the earth for some time ; so that it is only found in borders of corn fields, or the sides of inclosures, &c. &c. We have not seen fit that we have an exact account of covering, &c. As it has been imagined that the cows eat it well in the pastures where this

plant

plant abounds, yield a quantity of rich milk, the plant Vegetables
food for
Cattle. has, from that circumstance, obtained its most proper English name of *milk-vetch*.

One of the greatest recommendations of this plant Its good
qualities. is, that it grows in poor barren ground, where almost no other plant can live. It has been observed in ground so poor, that even heath, or ling (*erica communis*), would scarcely grow; and upon bare obdurate clays, where no other plant could be made to vegetate, insomuch that the surface remained entirely uncovered, unless where a plant of this kind chanced to be established; yet, even in these unfavourable circumstances, it flourished with an uncommon degree of luxuriance, and yielded as tender and succulent, though not such abundant shoots, as if reared in the richest manured fields. In dry barren sands, also, where almost no other plant could be made to live, it has been found to send out such a number of healthy shoots all round, as to cover the earth with the closest and most beautiful carpet that can be desired.

The stalks of the milk-vetch are weak and slender, so that they spread upon the surface of the ground, unless they are supported by some other vegetable. In ordinary soils they do not grow to a great length, nor produce many flowers; but in richer fields the stalks grow to a much greater length, branch out a good deal, but carry few or no flowers or seeds. From these qualities our author did not attempt at first to cultivate it with any other view than that of pasture; and, with this intention, sowed it with his ordinary hay seeds, expecting no material benefit from it till he desisted from cutting his field. In this, however, he was agreeably disappointed; the milk-vetch growing the

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first season as tall as his great clover, and forming exceeding fine hay; being scarce distinguishable from lucerne, but by the slenderness of the stalk, and proportional smallness of the leaf.

Another recommendation of this plant is, that it is perennial. It is several years after it is sowed before it attains to its full perfection; but, when once established, it probably remains for a great number of years in full vigour, and produces annually a great quantity of fodder. In autumn 1773, Dr Anderson cut the stalk from an old plant that grew on a very indifferent soil; and, after having thoroughly dried it, he found that it weighed 14 ounces and a half.

The stalks of this plant die down entirely in winter, and do not come up in the spring till the same time that clover begins to advance; nor does it advance very fast, even in summer, when once cut down or eaten over: so that it seems much inferior to the above-mentioned grasses; but might be of use to cover the worst parts of a farm, on which no other vegetable could thrive.

Yellow
vetchling.

2. The *common yellow vetchling* (*Lathyrus pratensis*), or *everlasting tare*, grows with great luxuriance in stiff clay soils, and continues to yield annually a great weight of fodder, of the very best quality, for any length of time. This is equally fit for pasture or hay; and grows with equal vigour in the end of summer as in the beginning of it; so would admit being pastured upon in the spring, till the middle, or even the end of May, without endangering the loss of the crop of hay. This is an advantage which no other plant except clover possesses; but clover is equally unfit for early pasture or for hay. Sainfoin is the only plant whose qualities approach

proach to it in this respect, and the yellow vetchling will grow in such soils as are utterly unfit for producing fainfoin.—It is also a perennial plant, and increases so fast by its running roots, that a small quantity of the seed would produce a sufficient number of plants to fill a whole field in a very short time. If a small patch of good ground is sowed with the seeds of this plant in rows, about a foot distance from one another, and the intervals kept clear of weeds for that season, the roots will spread so much as to fill up the whole patch next year; when the stalks may be cut for green fodder or hay. And if that patch were dug over in the spring following, and the roots taken out, it would furnish a great quantity of plants, which might be planted at two or three feet distance from one another, where they would probably overspread the whole field in a short time.

3. The common blue tare seems more likely than the Blue tare. former to produce a more flourishing kind of hay, as it abounds much more in seeds; but as the stalks come up more thinly from the root, and branch more above, it does not appear to be so well adapted for a pasture grass as the other. The leaves of this plant are much smaller, and more divided, than those of the other; the stalks are likewise smaller, and grow to a much greater length. Though it produces a great quantity of seeds, yet the small birds are so fond of them, that, unless the field were carefully guarded, few of them would be allowed to ripen.

4. The *vicia sepium*; purple, everlasting, or bush-vetch. Bush-
Our author gives the preference to this plant beyond vetch.
all others of the same tribe for pasture. The roots of it spread on every side a little below the surface of the ground,

~~Vegetable~~ ground, from which, in the spring, many stems arise
~~food for~~
~~Cattle.~~ quite close by one another; and as these have a broad tufted top covered with many leaves, it forms as close a pile as could be desired. It grows very quickly after being cut or cropt, but does not arrive at any great height; so that it seems more proper for pasturage than making hay; although, upon a good soil, it will grow sufficiently high for that purpose; but the stalks grow so close upon one another, that there is great danger of having it rotted at the root, if the season should prove damp. It seems to thrive best in a clay soil.

~~Everlasting~~ ~~pea.~~ Besides these, there are a variety of others of the same class, which he thinks might be useful to the farmer. The common garden everlasting pea, cultivated as a flowering plant, he conjectures, would yield a prodigious weight of hay upon an acre; as it grows to the height of ten or twelve feet, having very strong stalks, that could support themselves without rotting till they attained a great height.

~~Achillea~~
~~millefolium.~~ One other plant, before unnoticed, is recommended by our author to the attention of the farmer; it is the common yarrow (*Achillea millefolium*), or hundred-leaved grass. Concerning this plant, he remarks, that in almost every fine old pasture, a great proportion of the growing vegetables with which the field is covered consists of it; but the animals which feed there are so fond of the yarrow, as never to allow one seed-stalk of it to come to perfection. Hence these seed-stalks are never found but in neglected corners, or by the sides of roads; and are so disagreeable to cattle, that they are never tasted; and thus it has been erroneously thought that the whole plant was refused by them.—The leaves of this plant have a great tendency to grow very thick upon

upon one another, and are therefore particularly adapted for ^{Vegetables} ~~pasturage~~ ^{food for} ~~Carde~~. rich fields that are naturally fit for producing a large and succulent crop of grass. It grows also upon clays; and is among the first plants that strike root in any barren clay that has been lately dug from any considerable depth; so that this plant, and thistles, are usually the first that appear on the banks of deep ditches formed in a clayey soil. All animals delight to eat it; but, from the dry aromatic taste it possesses, it would seem peculiarly favourable to the constitution of sheep. It seems altogether unfit for hay.

Besides these plants, which are natives of our own ^{Lucerne.} country, there are others which, though natives of a foreign climate, are found to thrive very well in Britain; and have been raised with such success by individuals, as highly to merit the attention of every farmer. Among these the first place is claimed by lucerne:

This is the plant called *medica* by the ancients, because it came originally from Media, and on the culture of which they bestowed such great care and pains. It has a perennial root, and annual stalks, which, in a good soil, rise to three feet, or sometimes more, in height; its leaves grow at a joint like those of clover; the flowers, which appear in June, are purple; and its pods are of a screw-like shape, containing seeds which ripen in September. All sorts of domestic cattle are fond of this plant, especially when allowed to eat it green, and black cattle may be fed very well with the hay made from it; but an excess of this food is said to be very dangerous.

Lucerne has the property of growing very quickly after

Vegetables after it is cut down, insomuch that Mr Rocque has food for Cattle. mowed it five times in a season, and Dr Anderson affirms he has cut it no less than six times. It is, however, not very easily cultivated ; in consequence of which it sometimes does not succeed.

Timothy grass. Another grass was brought from Virginia, where it is a native, and sown by Rocque in 1763. This grass is called *timothy*, from its being brought from New-York to Carolina by one Timothy Hanson. It grows best in a wet soil; but will thrive in almost any. If it is sown in August, it will be fit for cutting in the latter end of May or beginning of June. Horses are very fond of it, and will leave lucerne to eat it. It is also preferred by black cattle and sheep; for a square piece of land having been divided into four equal parts, and one part sowed with lucerne, another with fainfoin, a third with clover, and the fourth with timothy, some horses, black cattle, and sheep, were turned into it, when the plants were all in a condition for pasturage; and the timothy was eaten quite bare, before the clover, lucerne, or fainfoin, were touched.

One valuable property of this grass is, that its roots are so strong and interwoven with one another, that they render the wettest and softest land, on which a horse could not find footing, firm enough to bear the heaviest cart. With the view of improving boggy lands, therefore, so as to prevent their being poached with the feet of cattle, Dr Anderson recommends the cultivation of this kind of grass, from which he has little expectation in other respects.

Grazing compared with the plough. On this subject, of the kind of plants most proper to be raised for feeding cattle, one general question ought not to pass unnoticed concerning the propriety of feeding

ing them upon roots and plants cultivated by the aid ^{Vegetables} _{food for Cattle.} of the plough, or upon leaving them to derive their subsistence from lands allowed to remain continually in pasturage. The advantages of the latter practice are set forth by Thomas Davis, Esq. of Longleat, in the following words *. " Experience sufficiently evinces the extreme difficulty of persuading tenants that they get more (generally speaking) by feeding their lands, than by ploughing them ; yet it requires very few arguments to convince a landlord, that, in cold wet land especially, the less ploughed land you have, the less you put it in the tenant's power to ruin your estate. That a tenant of 60*l.* per annum on a dairy farm will get money, while a corn farm of the same size will starve its occupier (though perhaps the former gives 15*s.* per acre for his land, and the latter only 10*s.*), is self-evident. The plough is a friend of everybody's, though its advantages are very far from being particularly and locally felt ; corn being an article that will bear keeping till the whim or caprice, or supposed advantage of its possessor, call it forth. But the produce of the cow is far otherwise. Cheese must necessarily be sold at a certain period : it is a ponderous article ; and one-twelfth, or at least one-fifteenth of its value, is often paid for carrying it to a fair 50 miles off ; and the butter and skimmed milk find their way no great distance from home, as is evident by the price of butter varying frequently one-third in 20 or 30 miles. Every inhabitant of Bath must be sensible, that butter and cheese have risen one-third or more in price

* *Bath Papers.* vol. iii.

Vegetables price within 20 years. Is not this owing to the great
^{food for}
Cattle. encouragement given to the plough and to grazing,
at a time when, on account of the increased demand
for milk, cream, butter, and cheese, every exertion on
behalf of the dairy should have been encouraged?" &c.

In some remarks on this letter by Mr Billingsley, the same superiority of dairy farms to the arable kind is asserted in the most positive terms. "Perhaps (says he) there cannot be a stronger proof of the inferiority of the plough, with respect to profit, than the superior punctuality of the dairy farmer in the payment of his rent. This observation, I believe, most stewards who superintend manors devoted partly to corn and partly to dairy farms, will verify; at least I have never met with one who controverts it. But perhaps the advocate for the plough will desire me not to confound the abuse of a thing with its intrinsic excellence; and say, that the generality of corn farmers are most egregious slovens; that lands devoted to the plough are not confined to such a mediocrity of profits as 20s. per acre; that the produce of artificial grasses (without which a well managed arable farm cannot exist), far exceeds that of natural grass both in respect of quantity and nutrition: that the straw yard is a most convenient receptacle for the cow when freed from the pail. These, and many other reasons, may be adduced to shew the propriety of walking in the middle path, and of judiciously blending *arable* with *pasture*, in the proportion perhaps of *three* of the latter to *one* of the former."

On these letters we shall only remark, that for the good of mankind we hope the notions contained in them will never be acted upon, even for the shortest period, on account of their tendency to raise the price of bread. They

certainly never can be followed during a long period, as we are satisfied that they are founded on error, and have arisen chiefly from not attending to the usual situation of persons holding small corn and dairy farms. The dairy farmer usually possesses a sufficient capital, which enables him to carry on his business, which is of a very simple nature, to complete advantage; whereas, this is seldom the case with the holders of small corn farms: but where the latter possess sufficient capital to enable them to derive from the land every advantage which it is capable of bestowing, there can be no doubt of the superiority of the plough. In such cases, however, it is necessary that the arable farmer possess a large stock of cattle, to enable him to consume advantageously the produce of the lands, and to preserve them in an improving condition by large quantities of manure. In the Bath Papers, vol. v. p. 43. we have a method proposed by Mr Wimpey of improving small arable farms in such a manner as to make them yield as much milk, butter, and cheese, as those which are kept continually in pasture. He agrees with the maxim already mentioned, that small arable farms do not afford to the occupier so good a maintenance as dairy farms of the same value; and that the possessor of a dairy farm will do well and save money, while the former, with much toil and trouble, is starving himself and family. Notwithstanding this, he maintains, that there is an essential difference between ground that is naturally arable, and such as is by nature adapted for pasture. Land which is naturally arable, according to him, can by no means be converted into pasture of any duration. " Such as, from a wild state of nature, overrun with furze, fern, bushes and brambles, has been rendered

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Vegetables rendered fertile by means of the plough, must be kept in food for Cattle, that improved state by its frequent use; otherwise it would soon revert to that wild barren state which was its original condition. A farm, therefore, which consists wholly, or almost so, of land that is properly arable, must ever continue arable; for it is not practicable to render it in any degree fertile but by means of the plough, or to keep it long in that state even when it is made so." He is of opinion, however, that by raising crops proper for feeding cattle, the possessor of an arable farm may raise as great a number of horned cattle as one who has a pasture farm; the only question is, Whether he can be reimbursed of his expences by the produce? "To ascertain this fact (says he), we must inquire what may be the average expences of keeping a milch cow on a dairy farm for any given time. It is said, upon very good authority, that the expence is generally from 3l. to 3l. 10s. per annum. Two acres and a half of pasture fit for this use is sufficient to keep a cow the whole year through, and such land is valued at from 25s. to 30s. per acre. At 25s. the keeping of each cow would amount to 3l. 2s. 6d. per annum. A dairy farm, therefore, consisting of 48 acres, at 25s. per annum, would amount to 60l. rent; and the number of cows that might be kept on such a farm would be about 20. In the next place, with regard to the expence of keeping a cow upon food raised in arable land as a succedaneum for grafts, we are assured by unquestionable authority, that a bushel of potatoes, given half at night and half in the morning, with a small allowance of hay, is sufficient to keep three cows a day; by which allowance their milk will be as rich and as good as in the sum-

mer months when the cows are in pasture. An acre Vegetables
of land, properly cultivated with potatoes, will yield food for
337 bushels; and the total expence of cultivation, rent
and tithe included, will not exceed 6l. 13s. If three
cows eat seven bushels per week, then they would eat
364 bushels in a year; and 20 cows would consume
2433 bushels." So that, according to this calculation,
seven acres and a quarter would nearly maintain as
many cows as on the pasture farm could be maintained
by 48 acres. If then the cultivation of one acre of
ground costs 6l. 13s. the cultivation of seven acres and
a quarter will cost about 48l. We have seen, how-
ever, that the rent of a dairy farm capable of main-
taining 20 milch cows, is not less than 60l. so that
the calculation is thus entirely in favour of the arable
farm; seven or eight acres of the arable farm being
superior by 12l. in value, when cultivated with pota-
toes, to 48 acres of meadow or pasture ground. "It
must indeed be observed (adds our author), that in
this statement no allowance is made for the small quan-
tity of hay given to the cows with the potatoes. It
must be noted also, that the account of cultivation
is charged with 40s. an acre for manure, and some
expence for ploughing, which of right is chargeable
to the crop of wheat that is to follow. Now, if we
deduct 40s. an acre from the expence of cultivating
the potatoes, it reduces the sum to 4l. 13s.; and the
whole expence upon seven acres and a quarter is thus
less than 34l. and consequently the keeping of 20 cows
is little more than half to the occupier of the arable
farm what it is to the occupier of the grazing farm. If
this conclusion be fairly drawn, and the calculation
free from errors, it is matter of the greatest import-

Vegetable
Food or
Cattle ance, especially to the little arable farmer. It plainly
raises him from a state of acknowledged inferiority to
one greatly superior."

Objection
answered
from an
experiment
of Mr
Vagg. Our author next proceeds to obviate an objection, "that the whole of his reasoning must be indecisive, as relating only to potatoes." In opposition to this, he adduces an experiment made on a pretty large scale by Mr Vagg; from which it appears, that cabbages, when raised upon arable ground, are nearly as much superior to a natural crop as potatoes are. Twelve acres were employed in this experiment, and those of an indifferent quality. The rent was 30s. per acre, and the whole expence of culture and carting off the crop amounted only to 1l. 14s. so that all the cost of the

Number of
cattle fed
from 12
acres of
cabbages. twelve acres was 38l. 9s. From the produce were fed 45 oxen and upwards of 60 sheep; and he was assured that they improved as fast upon it as they do in the best pasture months, May, June, and July.

"Now (says Mr Wimpey), if instead of 60 sheep we reckon 15 oxen, or that four sheep are equal to about one ox, in which we cannot err much; then 60 oxen were kept well for three months, or, which is the same thing, 15 for a whole year, for 38l. 9s.; and consequently 20 oxen would cost 51l. 5s. 4d. which is not quite 3l. more than the keeping of 20 cows would cost in potatoes. Turnips, turnip-rooted cabbage, carrots, parsnips, and some other articles, by many experiments often repeated, have been found quite adequate to the same valuable purposes; at least so far as to be more lucrative than meadow or pasture. Clover and rye-grass are omitted, as having been long in general practice; but are usually very short of the advantages which may be derived from the cultivation

vibration

vation of the other articles recommended." Sainfoin is Vegetables
greatly recommended: but our author acknowledges food for
that it makes but a miserable appearance the first year, Cattle.
though afterwards he is of opinion that one acre of
sainfoin is equal to two of middling pasture ground;
for which reason he accuses the farmer of intolerable
indolence who does not cultivate so useful a plant.
On this subject, however, we must remember, that the
culture of sainfoin is clogged with the loss of one if
not two crops; which may sometimes be inconvenient,
though afterwards it remains in perfection for a great
number of years. The most advantageous method
of raising it he supposes to be after potatoes. In
this way it will thrive even upon very poor ground;
as the culture and manure necessary for the potatoes
both pulverize the soil and enrich it to a sufficient
degree.

The opinions here stated are supported and maintained by the best informed authors, in such a manner as to leave no doubt of their truth. The Reverend Edmund Cartwright recommends, upon arable farms, the following courses of crops with a view to this subject *. "On strong lands, says this writer, the following courses I have known successfully practised: 1st, beans; 2d, wheat; 3d, cabbages; 4th, barley; 5th, clover: this course presents three ameliorating crops to two exhausting ones. 1st, Potatoes; 2d, wheat; 3d, turnips (carried off); 4th, barley, and sometimes oats: this was a very common course about twenty years ago in a bleak part of Derbyshire, where I formerly resided. 1st, Wheat; 2d, tares,

* *Communications to the Board of Agriculture*, vol. iii.

Vegetables and afterwards turnips ; 3d, barley ; 4th, clover, or 5th, wheat ; 6th, tares ; 7th, oats ; 8th, turnips. These were the general courses, with few deviations, observed by a Leicestershire farmer.

" It admits not of a question," adds he, " that an acre of clover, tares, rape, turnips, or cabbages, will furnish at least twice the food that the same acre would have done had it remained in pasture : by any one of these courses, therefore, it follows, that the land would maintain at least as much stock as when in grass, besides producing every other year a valuable crop of corn. No calculation is made upon the value of the straw, which, whether consumed as litter or as food, will add considerably to the stock of manure.

" That the condition of the land would be improved there can scarcely remain a doubt upon the mind of any man who will consider the subject attentively. The plough, by pulverizing the soil and breaking its tenacity, not only gives admission to the fertilizing influence of the atmosphere, but, by intimately mixing the manure, prevents that tenacity from taking place in future, so long at least as the manure remains totally unexhausted. But as the soil will have a fresh and ample supply, every other year, the stock of manure, with its concomitant fertility, will rather accumulate than be diminished ; in consequence of which, whenever it is again converted into pasture, it will be in superior condition to what it was when first broken up."

We shall afterwards have an opportunity of attending to this subject when we come to consider the subject of feeding cattle. In the mean time, it may be remarked, that this branch of the art of the husbandman, has by no means hitherto been carried to its highest

highest perfection in this country; and that in proportion as it is improved, and cattle are more carefully fed, the value of the plough will appear more conspi- Profit from different Vegetables.

SECT. III.

OF THE COMPARATIVE PROFIT TO BE DERIVED FROM
THE CULTIVATION OF DIFFERENT VEGETABLES.

LIKE every other artist or tradesman, a husbandman ^{Circum-}
will always be under the necessity of regarding himself ^{as the servant of the community, and must endeavour} _{render ve-}
_{getables profitable or not.}
that will enable him to derive the greatest profit from the
portion of territory which he occupies. The product
of some soils and situations is so fixed by nature, that
it is in vain for human art or industry to alter her de-
stination. In our own and in many other countries,
there are extensive tracts of lofty and rugged moun-
tains, from which the art of agriculture seems to be
for ever banished. Such situations belong exclusively
to the shepherd and his flock, to the utter exclusion of
the plough. Even on some arable lands it may be found
fruitless to attempt to rear many of the more valuable
vegetable productions. In many bleak and unsheltered
fields of the higher country of Scotland, in which tur-
nips and oats are cultivated with tolerable success, it
would be in vain to expect regular crops of wheat;
and though potatoes are found to prosper in a sandy,
or even a mossy soil, it would be in vain to expect

*Plants from them to produce an equally valuable crop upon a stiff
different
Vegetables, clay, in which the roots cannot swell or expand to a
proper size.* In forming a plan of agriculture, therefore, the husbandman must not overlook the peculiar nature of the soil that has fallen to his lot, or its physical relation to the nature of certain vegetables, as he can only hope for success by adapting the one of these to the other.

The husbandman must also have a special regard to the state of the market to which his commodities are to be brought. It is in vain for him to cultivate large quantities of roots, such as potatoes or carrots, at a distance from great towns, which alone can afford a market for them, unless he intend to consume them upon his own farm by feeding cattle. In a part of the country, however, in which great breweries are established, if his soil is fit for the purpose, he may safely venture to rear large quantities of barley; as he cannot in such a situation be at any time destitute of a market. Hence we can perceive, that it is the state of the market which must at all times regulate the enterprises of the agriculturist, and the kind of crops which he is to bring forward. Thus also we see the mode in which agriculture may be most successfully encouraged by a nation. Let an abundant market be provided for the produce of the soil, and that produce will intallably be augmented. In this way, it is evident that the consumption of grain, by means of distilleries or breweries, is highly favourable to the production of it in great quantities. They are even favourable to the existence of pierry, or of abundance of bread for the use of the people. In good times, by creating a ready market, they give acti-

vity to the husbandman, and in bad seasons their operations can be arrested by law, and the superfluous quantity of grain which was meant to be consumed by them, can be converted into human food. Thus they operate in some measure like a great public granary, in which provisions should be kept against an accidental scarcity.

It may sometimes happen, that by the character of the age in which he lives, and the state of the market which it produces, a husbandman may find himself most profitably employed, when rearing a kind of food which is by no means the most advantageous to the population of his country. This takes place, when he is employed in preparing butchers meat instead of bread; that is, when he finds it more profitable to rear upon his lands vegetables which can only be consumed by cattle, and thus contribute only in an indirect manner to the sustenance of the human species, than to cultivate those vegetable productions which are suited to the human stomach, and which therefore directly and immediately afford subsistence to man. According to Archdeacon Hislop's comparative statement, lately published, the weight of food from an acre of arable land, on the average of three years, a fallow year being included, is nine and a half times greater than from an acre of feeding stock.

The Reverend Dr Walker of Collington, professor of Pasturage and agricultural history in the university of Edinburgh, in a memorial addressed to the Board of Agriculture, states the subject thus*: He observes, that a Scots acre of good

* *Communi.: vol. iii.*

Profit from land, of 40 shillings rent, which is capable of producing ^{different} ~~Vegetables~~ 1280 pounds of oat-meal in a season, will only produce 120 pounds weight of mutton. He then adds, "The difference which arises to the public from these two different methods of occupying land, is indeed most surprising. A labourer, a manufacturer, or a mechanic, often consumes at the rate of a pound of meat each day. The 120 pounds of meat, therefore, afforded by the above acre, cannot support such a consumer above one-third of the year. He requires no less than three such acres to supply his wants for the single article of meat. On the other hand, the single acre affording 1280 pounds of oat-meal is capable of supporting three laborious men in health and vigour, and with less additional sustenance than the former consumer requires.

"The labourer, therefore, who lives chiefly on meat, demands for his support about nine times the quantity of land that is necessary for the sustenance of a labourer who lives chiefly on grain."

Let it even be supposed, however, that one pound of mutton contains in itself as much substantial nourishment for the human constitution, as two pounds weight of oat meal; still it will follow, that land cultivated for the production of oats, will support a population five times greater in number, than can be supported by the same land when used for the pasture of sheep; and, where one million of people are found to exist upon a territory occupied in the one way, between five and six millions of people might exist upon the same land, if it were cultivated for raising grain, and if the inhabitants would consent to use it as their food. Were any contrivance adopted,

of the nature of those already mentioned, for converting the succulent roots of potatoes, carrots, &c. into vegetables, dry meal or flour; the same proportional difference of population would continue to exist, between nations in which that kind of flour should be consumed as human food, and in which it should be used for feeding cattle: For a man always commits an enormous waste of food, who, instead of eating grain himself, gives it to an inferior animal, in the expectation of afterwards receiving an equivalent, by devouring the flesh of that animal.

Accordingly, it seems impossible for any nation to reach a very extensive degree of population, unless where men the people at large consent to subsist, in a very considerable degree, upon vegetable food. In China, where the practice of polygamy renders the families of rich men very numerous, and where the equal distribution of the property among the children of the same family prevents the accumulation of great wealth by individuals, almost all persons have found it convenient or necessary to relinquish the ordinary use of butchers meat, and to have recourse to vegetable food. It is only in consequence of this circumstance, that the enormous population of that empire is supported. The quantity of butchers meat consumed in a country will, therefore, always in spite of every agricultural improvement, set bounds to its population. A nation of hunters and shepherds, who live upon wild animals, or upon flocks and herds, must always be few in number. By agriculture, the numbers of these animals may indeed be increased; but the men who can find subsistence by consuming them, will always be five or six times fewer in number, than might live upon the same

Profit from same territory, were the cattle expelled, and the lands
~~different~~
Vegetables occupied in rearing food to be immediately used by
man.

It is to be observed, however, that, independent of the public taste and manners, this last idea of the expulsion of cattle, or the total relinquishment of animal food, is in our soil and climate, at least in the present state of the science of agriculture, merely a speculative notion, incapable of being reduced into practice, consistently with the rules of good husbandry. Our soil requires to be constantly renewed by the addition of manure, which can only be procured of the best quality and in abundance, at a distance from great cities, by means of cattle. We have already taken notice of the great superiority of British over French husbandry. That superiority arises entirely from the cattle kept upon our farms, which enable their owners, by manure and by ameliorating green crops, to raise larger quantities of corn than can be done in any other way, while, at the same time, a great supply of butchers meat is over and above provided. When cattle, therefore, are reared only in moderate numbers, for the purpose of consuming the green crops upon a farm, to afford the means of improving the fertility of the soil, they ought not to be regarded as diminishing the quantity of human food; but, on the contrary, as greatly increasing it, by enabling the agriculturist to bring to market larger quantities of grain than could otherwise be done; while, at the same time, a supply of the most nourishing of all food is over and above provided for the use of man. Thus Providence seems to have contrived to render it the interest of the human race to preserve, and to give subsistence to great numbers of the inferior animals, by enabling

enabling these animals to pay liberally for the protection ^{Profit from different Vegetables.} which they receive.

With these general considerations, however, the practical agriculturist, or husbandman, may have no ^{Circumstances that lead husbandmen to prefer pasture to the rearing of grain.} thing to do. To succeed in his profession, he must accommodate himself to the public taste, or to the state of the market around him; and must consider what commodity, whether grain or butchers meat, will there bring the best reward for his labour. He may even find the state of the market affected by other circumstances, than the mere taste of the public for butchers meat, in preference to vegetable food; although that must always be of great importance among a luxurious people. Conquering nations, who extend their political dominion over distant regions, never fail to draw to their native country a very great portion of the wealth of the vanquished states. The victorious nation never fails, in such cases, to contain a great number of wealthy individuals, whose revenue is not derived from the cultivation of their native soil, or from any branch of manufacture or of commercial industry carried on by them upon it; but which consists of money drawn from the remote provinces of the empire, in consequence of estates possessed, or fortunes acquired there, in the service of government. The result of such circumstances naturally is, that these wealthy individuals not only live at home in a luxurious manner, and increase to an immense extent the consumption of butchers meat by themselves and their numerous retinue; but for the sake of ostentation, and as the only means of employing their wealth, they maintain great numbers of carriages and of riding horses. To support such establishments, they themselves

Profit from ^{different} selves not only convert large tracts of territory from ^{Vegetables,} arable into pasture lands; but even the whole husbandmen of the country are induced to do the same, to derive a profit from supplying them with butchers meat, and with food for their pleasure horses. In the mean time, the grain that may be wanted for the consumption of the people, whether rich or poor, being a commodity which is easily preserved and transported, must be brought from foreign nations, by a portion of the superfluous wealth of the state; and thus a rich and prosperous people may come to depend upon foreigners for a morsel of bread; and, when these foreign nations happen to experience an unfortunate season, this wealthy people may suffer all the horrors of famine upon a fertile soil, and in the midst of overflowing treasures.

Such was the state of Italy under the ancient Romans. Every part of it was adorned with the parks and villas and gardens of the nobles, who derived their revenues from the remote parts of the empire. This seat of dominion exhibited a picture of boundless splendour and magnificence. But the soil was entirely occupied in the service of ostentation or of luxury; and Italy, one of the most fertile corn countries in Europe, depended for grain upon Egypt, and the western provinces of Africa that border upon the Mediterranean. Such also, though perhaps in an inferior degree, seems to be the present state of Great Britain. It has acquired vast and fertile and populous provinces, within the torrid zone in the east, from which individuals are annually transporting home immense treasures obtained in the public service. In the west, also, within the same torrid zone, by a great expence of treasure and of hu-

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man lives, the cultivation of certain valuable commodities has been established ; and from estates situated there, individuals residing at home now derive great revenues.

The principles which regulate human affairs are unalterable ; and in every age the same causes are attended with the same consequences. What occurred in ancient Italy, took place among us as soon as the possession of distant territories had leisure to display its natural effects. Britain formerly not only produced abundance of grain, for the support of its own inhabitants, but it possessed a considerable surplus for exportation. After the acquisition of foreign possessions, this surplus produce gradually ceased to exist ; and it appears from documents, which the legislature has acknowledged to afford authentic and complete evidence of the truth of the fact, that, for twenty years past, notwithstanding all our agricultural improvements, and the waste lands that have been brought under the plough, the produce of grain is annually becoming more and more unequal to the consumption ; and this decrease appears in some measure to keep pace with the increasing value of our distant possessions. In the mean time, we are annually coming under the necessity of purchasing larger and larger supplies of grain, from the foreign states of Europe or of North America ; and thus these nations, without undergoing the imputation of usurpation, and without encountering the hazard of an unfriendly climate, have been enabled through the medium of our luxury to obtain a share of the riches of Hindostan, and of the profits of our West India cultivation. In the mean time their agriculture is encouraged, while we are made to depend upon them for the necessities of life. After all, it appears unreasonable, and would perhaps be improper,

to

Principles of Cultivation. to regret a state of affairs, which is the result of national aggrandizement, and of the superiority and successful enterprises of our countrymen. Still, however, it is obviously to be wished, that, so far as agriculture is concerned, we could be restored to the state of independence which our ancestors enjoyed, when they were able, from their own soil, to supply themselves with the necessaries of life : such a state is sometimes necessary to the independent existence of a community, and is at all times conducive to its welfare. It can only however be produced by means of agriculture. Therefore,

Ye generous Britons, venerate the *plough*,
And o'er your hills and long withdrawing vales,
Let autumn spread her treasures to the sun ;
So with superior boon may your rich soil,
Exuberant, nature's better blessings pour
O'er every land, the naked nations clothe,
And be th' exhaustless granary of a world !

THOMSON.

SECT. IV.

GENERAL PRINCIPLES OF CULTIVATION.

IT is not our intention here to enter into a minute disquisition, concerning the nature of vegetables, or the different substances with which they may be connected, in their growth or in their decay. Such investigations, in a proper arrangement of the sciences, ought to be left

to chemistry; but even that science, so far as vegetable substances are concerned, is still in such a state of imperfection, that a detail of the experiments and opinions of philosophical chemists, concerning vegetables, would as yet afford but a very trifling portion of useful information to the husbandman. We shall therefore content ourselves with here stating such general remarks, as appear necessarily connected with the important art of which we are now treating.

A vegetable is not to be regarded merely as a piece of matter, or as a mixture of certain material substances. It is an organized being, possessed of life, which is derived from another similar organized being that existed previous to itself; and this former organized and living being derived its constitution from a parent stem, which grew out of a still older plant, up to an antiquity of which we have no knowledge. A vegetable, in this manner, not only has a birth, but it also has a growth, which is supported by food that it takes in and conveys by peculiar organs to the particular parts for which it is destined. When it has arrived at maturity, or reached the perfection of its form and constitution, a vegetable, like an animal, begins to decay, and finally dies, and, by a process of putrefaction, is converted into a kind of earth.

To the life of vegetables, in the same manner as to the life of animals, the presence of atmospheric air is necessary. They also require a certain moderate degree of heat; without which their growth cannot proceed, although a great degree of it is utterly fatal even to their texture. That they require moisture, is equally obvious; as appears from the ordinary effect of rain, or of the continued want of it, upon fields and plants.

They

Principles of Cultivation. They require likewise to be inserted in the earth, or in some way connected with a collection of its particles; for although some plants, particularly the bulbous-rooted kinds, vegetate in pure water and air alone, it appears that they acquire little addition of solid substance, and that neither they, nor any of the other larger plants, reach perfection, or produce seed, unless planted in the earth, or supplied with a portion of it.

Four kinds of soil. As all soils are by no means equally adapted for supporting vegetables, or bringing them to maturity, it is necessary for the husbandman to attend to their nature, and the modes in which they may be altered or ameliorated for his use. Independent of these hard concretions, which obtain the name of stones or rocks, it is to be observed, that the looser and more divisible earth which covers most part of the surface of the globe, and receives the appellation of *the soil*, may, upon the whole, and with sufficient accuracy for practical purposes, be divided into four kinds, which are in general mixed with each other, but which receive their name, in ordinary language, from the kind that predominates, or is most abundant. These are sand, clay, chalk, and garden mould. Of these, sand and clay are in some measure the opposites of each other, while chalk forms a kind of medium between them. Sand allows water to filter rapidly through it, and speedily becomes dry, while clay is extremely tenacious of moisture; but a mixture of chalk renders sand considerably more tenacious of water, while it renders clay more loose and easily penetrated. None of these soils, when pure, are valuable for the purposes of agriculture.—Sand does not sufficiently retain water for the use of vegetables; nor does clay suf-

fer their roots to expand with freedom in quest of nourishment. Chalk, or, as it is usually called, a calcareous soil, is not of itself adapted for raising useful plants; for, although it may not have the mechanical defects of sand and clay, yet, it is found by experience to be of little value to them, either in consequence of its tendency to destroy their texture by its corrosive quality, that is, by having too much chemical affinity with the materials of which they consist, or from its not containing within itself the proper materials necessary to them as food.

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tion.

The fourth kind of soil we have denominated garden mould; because it is in its highest perfection when it approaches nearest to the rich black earth which receives that appellation. This is the most proper of all kinds of soil for rearing the whole of those vegetables which are accounted valuable in our climate. In proper circumstances, that is, with a moderate degree of heat and of moisture, it never fails to send forth and to bring to perfection an abundant crop. In proportion to the degree in which any soil consists of this black mould, its value increases. If, therefore, a husbandman could cover the portion of territory allotted to him with a tolerable depth of this kind of soil, nothing more would be necessary to the success of his enterprises, as he could rear whatever vegetables he thought fit, in perfection, and in great profusion. It is to be observed, however, that this kind of mould or soil cannot be relied upon as permanent. If crops of grain should be taken from it year after year, it would soon lose its fertile qualities, and become unfit for the purposes of a prosperous agriculture. Here then is the remarkable difference between this kind of soil and the three others

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Principles of Cultivation. Whatever properties these possess are unperishing, and can only be altered or modified by the operation of a fierce heat. Unfortunately, however, in their pure state, as already mentioned, they are of little value to the husbandman; and it is only in proportion to the degree in which they are mixed with the dark coloured or garden-mould, that they become adapted to his purposes: but as the qualities of this mould are of a transitory nature, it is of the utmost importance, and ought indeed to form the great basis of every theory of agriculture, to explain how they may be preserved in existence, or restored when lost.

Nature of garden mould.

To understand this subject correctly, it is necessary to consider the nature and origin of this fertile mould. It is evidently not one of those original substances which form a part of the great mass of the solid globe of the earth, but appears to be the result of the operations and of the destruction of living and organized beings that have existed upon it. "Were a naked rock, (says Mr Headrick, in an essay * which we shall afterwards have occasion to mention), suddenly thrown up from the sea or from the bowels of the earth, the first plants which nature would place upon it, would be the various species of *lichens*, and such as can subsist wholly upon what they imbibe from the air, without needing a soil in which to push their roots. These plants serve the double purpose of clothing the rock, and thus preventing the fine particles that are dissolved by air and moisture from being washed away, and, from their growth

Process by which nature fertilizes the earth.

* *Communications of the Board of Agriculture*, vol. ii.

growth and dissolution, of accumulating vegetable Principles
soil for the sustenance of more succulent plants. The ^{of Cultiva-}
rock is thus gradually made to acquire such a depth
of soil, that it becomes able to sustain not only grasses
and shrubs, but may become a receptacle for the oak
itself." The progress here stated is correct; but some
circumstances must be added to it, to render it practi-
cally useful to the husbandman. It is to be observed,
then, that animal substances, after they have ceased
to form a part of a living body, have a tendency to
proceed rapidly into a state of putrefactive fermenta-
tion, by which the greatest part of their mass is render-
ed volatile. When animal substances are mingled with
vegetables, they speedily communicate their own fer-
mentation or putrefaction to the vegetables, which by
means of it are decomposed, fall to pieces, and are
transformed into that kind of black earth, which we
have called garden mould, and which forms the most
fertile of all soils for the production of vegetables.
It is by this process then, that is, by the fermentation
of vegetable by means of animal substances, that the
surface of this globe has been fertilized, or a black and
rich mould produced upon it, as we daily see taking
place in a variety of situations. No sooner do the
small lichens or mosses cover the face of the naked
rock, or gravel, or clay, than a variety of species of
small animals appear, and feed upon them. As the
plants and animals die in succession, their substances
mingle and give rise to the putrefaction already men-
tioned, which is productive of a small portion of soil.
A new race of plants of greater strength and bulk rises
upon the ruins of the first, and supports larger animals,
all destined in their turn to perish and to increase the
quantity

Principles of Cultivation. quantity of fertile soil. More valuable grafts soon supplant the original small and coarse vegetables, and the spot assumes the appearance of a rich verdure. New species of animals also begin to inhabit it : snails and worms abound ; and by their remains contribute to the dissolution of the roots of plants which everywhere penetrate the new soil, and to the decomposition of the stems which periodically fall down. When the soil has acquired sufficient depth, it is sheltered by shrubs ; and, lastly, by forest trees, under the shade of which the larger animals exist. The trees shed their leaves every season, and every season consequently gives an additional layer or *stratum* of fertile mould to the soil : and thus, while the forest endures, the fertility of the territory on which it stands continues to be augmented by its spoils, and by the bodies of the animals which repair to it for shelter.

This process, by which nature gives fertility to the earth, or creates the rich mould on which vegetables flourish, ought to be imitated by the husbandman ; and, in fact, it has been imitated, in consequence of a knowledge that is derived from experience and from practice, rather than from the general speculations of science. The imitation of nature upon this point constitutes the art of producing manures, which will be afterwards considered. The principle upon which it proceeds, rests upon this foundation, which is known to be true in fact, that the fermentation of animal and vegetable substances produces that kind of dark rich mould which forms the most fertile soil.

In what way, or by what peculiar operation, this kind of mould or soil becomes so highly conducive and subservient to the growth of plants, is a point of more difficult

difficult research, and is fortunately of less importance to be known to the practical agriculturist. It may be observed, however, that this mould possesses, in an eminent degree, all the requisites necessary to the success of vegetation. It retains moisture, which is so necessary to that process, without, at the same time, keeping hold of it with that retentiveness which, in clay, has the effect of injuring the roots of the plants. As this mould consists of the remains both of animal and vegetable life, it necessarily contains an immense variety of ingredients which have different degrees of chemical affinity to each other. By the operation of these affinities in bringing the different substances into new combinations, a great quantity of heat must be continually produced or evolved, as occurs in so many chemical processes. By this heat the roots of the plants will be nourished, especially when assisted by the heat which they themselves throw out or produce when germinating. Thus, by the kind of soil now mentioned, or by the aid of manure, the defects of a cold and ungenial climate may, in some measure, be rectified, and the seeds and roots of vegetables may be supplied with due and seasonable warmth. It is also probable, that what is called the exhausted state of a soil, in consequence of much ploughing, and many crops having been taken from it, may partly arise from this circumstance, that all the chemical affinities having at last operated, every particle of the soil remains at rest, and no more heat is produced by the activity of its parts.

That plants growing in fertile mould like that now mentioned, derive nourishment or food from it, cannot be doubted, since we see, that when taken out of it, or placed in another but less favourable soil, they speedily

Principles of Cultivation. quantity of fertile soil. This is the first principle of cultivation, which may be in general, that the spot assumes the character of the ex-
 New species of animals and worms abound; and the food which they require, or in a liquid state, to the dissolution of the soil where penetrate the roots, wash their organs in a stream of the stems which descend. In the sap there are two vessels, one ascending and one descending. The ascending vessel is found in shrubs; and by cutting a branch, it is seen to bring; and by cutting a stem, it is seen to descend into the wood of many trees. From this sap may be drawn oil, without hindrance to its growth. This sap ascends to the leaves, and undergoes some change by the time it reaches them. The leaves of vegetables appear to have an orifice similar to that which is found in the roots, by the organ called the *longitudo*. This sap, thus changed, descends to every part of the plant, and contributes to its growth by becoming substance. It would seem, however, that there is a circulation which circulates in plants, not only through the leaves, but also at their first origin, through the vessels of the roots; for if several different species are ingrafted upon the same common root, each is able to derive the sap peculiar to its own species from the common stock. Thus we have informed us, that vinegar, called *aceto*, is found variously combined in the roots of various trees; but it has never yet been observed that vinegar exists in any perceptible quantity in the leaves. That infatuate, therefore, who would extract vinegar from the root, by bringing together the ingredients which it finds and selects in the earth.

Wheat

any plant, whether great or small, is put in-
closed vessel, and strongly heated, allowing only
the smoke to escape, the residue in all cases is of the
same nature, and is called *charcoal*, or by the chemists
carbon. Of this carbonaceous matter a considerable
quantity is always found in rich garden mould, derived
no doubt from the remains of vegetable substances of
which that mould was originally formed. This car-
bonaceous matter, however, or charcoal, being inso-
luble in water, cannot in its ordinary state enter into
the vessels of growing vegetables; but, as it is render-
ed soluble by a variety of combinations, it is no doubt
found out in such a state by the fibres of growing roots,
and conveyed upwards in the juice. But as all vege-
table mould, and the charcoal or carbonaceous matter
which it contains, is the result of the ruins of vegeta-
tion, and as the lichens or vegetables of the coarsest
and simplest kind, which originally grow upon the na-
ked stone, have no other nourishment than water and
atmospheric air, it is probable, that out of these mate-
rials they are capable of forming the charcoal, which
constitutes the basis of their form, and of the constitu-
tion of every other vegetable. It is true, that the che-
mists still regard carbon or charcoal as a simple and
uncompounded substance; and they have not found it
in water, nor in atmospheric air, unless in the most mi-
nute degree, resulting probably from the combustion of
fires and the breathing of animals in inhabited coun-
tries. But although chemists have not hitherto been
able to find charcoal in the three simple substances,
oxygen, hydrogen, and azote, of which atmospheric
air and water are composed, it seems evident, that the
mighty Chemist who contrived this world and the con-

In some instances, there are some minerals which have a tendency to accomplish the decomposition of organic bodies, thereby to reduce them into a state of matter, losing in a great degree the qualities of life; and it is this that is produced by the fermentation of animal and vegetable substances, the former of which has now been described. Of the minerals which have this tendency, lime is the chief, and is the most conveniently in use, either pure or when combined with other substances under the form of marl. To the action of lime upon organic bodies, we shall

effect of lime, therefore, we shall call the attention of Principles
of Cultiva-
tion.

Where the ground has been suffered to remain uncultivated for many ages, producing all that time succulent plants which are easily putrefied, and trees, the leaves of which likewise contribute to enrich the ground by their falling off and mixing with it, the soil will in a manner be totally made up of pure vegetable earth, and be the richest, when cultivated, that can be imagined. This was the case with the lands of America. They had remained uncultivated perhaps since the creation, and were endowed with an extraordinary degree of fertility; nevertheless we are assured, by persons who have examined the lands in America, that such grounds as have been long cultivated, are often so much exhausted, as to be much worse than the generality of cultivated grounds in this country. Here, then, we have an example of one species of poor soil; namely, One species
of poor soil
destroyed
by lime. one that has been formerly very rich, but has been deprived, by repeated cropping, of the greatest part of the vegetable food it contained. The farmer who is in possession of such ground, would no doubt willingly restore it to its former state; the present question is, What must be done in order to obtain this end? We shall suppose the farmer tries lime. This substance, being of a septic nature, or having a tendency to reduce vegetable substances into a state of putrefaction, will act upon such parts of the soil as are not putrefied, or but imperfectly so; in consequence of which, the farmer will reap a better crop than formerly. The septic nature of the lime is not entirely altered by any length of time. In ploughing the ground, the lime is more and more perfectly mix-

Principles of Cultivation. ed with it, and gradually exerts its power on every putrescible matter it touches. As long as any matter of this kind remains, the farmer will reap good crops; but when the putrescible matter is all exhausted, the ground then becomes perfectly barren; and the caustic qualities of the lime are most unjustly blamed for *burning* the ground, and reducing it to a *caput mortuum*; while it is plain the lime has only done its office, and made the soil yield all that it was capable of yielding.

A species of poor soil meliorated by lime. When ground has been long uncultivated, producing all the time plants, not succulent, but such as are very difficultly dissolved, and in a manner incapable of putrefaction; there the soil will be excessively barren, and yield very scanty crops, though cultivated with the greatest care. Of this kind are those lands covered with heath, which are found to be the most barren of any, and the most difficultly brought to yield good crops. In this case lime will be as serviceable as it was detrimental in the other; for by its septic qualities, it will continually reduce more and more of the soil to a putrid state; and thus there will be a constant succession of better and better crops, by the repeated use of lime when the quantity first laid on has exerted all its force. By a continued use of this manure, the ground will be gradually brought nearer and nearer to the nature of garden mould; and, no doubt, by proper care, might be made as good as any: but it will be as great a mistake to imagine, that, by the use of lime, this kind of soil may be rendered perpetually fertile, as to think that the other was naturally so; for though lime enriches this soil, it does so, not by adding vegetable food to it, but by preparing what it already contains; and when

all is properly prepared, it must as certainly be exhausted Principles
as in the other case. of Cultiva-
tion.

Here, then, we have examples of two kinds of *poor* soils ; one of which is totally destroyed, the other great- Poor soils,
ly improved, by lime, and which therefore require very how resto-
different manures ; lime being more proper for the last red.
than dung ; while dung, being more proper to restore an exhausted soil than lime, ought only to be used for the first.

By attending to the distinction between the reasons for the poverty of the two soils just now mentioned, we will always be able to judge with certainty in what cases lime is to be used, and when dung is more absolutely necessary. The mere poverty of a soil is not a criterion whereby we can judge ; we must consider what hath made it poor. If it is naturally so, bearing heath and other coarse plants, we may almost infallibly conclude, that it will become better by being manured with lime. If it is *artificially* poor, or exhausted by continual cropping, we may conclude that lime will entirely destroy it. We apprehend, that it is this *natural* kind of poverty only which Dr Anderson says, in his Essays on Agriculture, may be remedied by lime ; for we can scarce think that experience would direct any person to put lime upon land already exhausted. His words are,

“ Calcareous matters act as powerfully upon land Mr Anderson's opinion on concern-
that is naturally poor, as upon land that is more richly impregnated with those substances that ing lime.
tend to produce a luxuriant vegetation.”

“ Writers on agriculture have long been in the custom of dividing manures into two classes, viz. *Enriching* manures, or those that tended directly to render the soil more prolific, however sterile it may be ; among the foremost

THEORY OF

..... which was dung : *Exciting manures*, or those which were applied to have a tendency to render the soil more fertile, merely by acting upon those enrichments that had been formerly in the soil, and giving them a new stimulus, so as to enable them to operate upon that soil which they had formerly fertilised. In which class of stimulating manures, *lime* was always allowed to hold the foremost place.

In consequence of this theory, it would follow, that lime could only be of use as a manure when applied to rich soils—and when applied to poor soils, would produce hardly any, or even perhaps hurtful effects.

"I will frankly acknowledge, that I myself was so far imposed upon by the beauty of this theory, as to be hurried along with the general current of mankind, in the firm persuasion of the truth of this observation, and for many years did not sufficiently advert to those facts that were daily occurring to contradict this theory.—I am now, however, firmly convinced, from repeated observations, that lime, and other calcareous manures, produce a much greater *proportional* improvement upon poor soils than such as are richer;—and that lime alone, upon a poor soil, will, in many cases, produce a much greater and more lasting degree of fertility than dung."

Thus far Dr Anderson's experience is exactly conformable to the theory we have laid down, and what ought to happen according to our principles. He mentions, however, some facts which seem very strongly to militate against it ; and indeed he himself seems to proceed upon a theory altogether different.

"Calcareous

* Calcareous matter alone (says he) is not capable of rearing plants to perfection ;—mould is necessary to be mixed with it in certain proportions, before it can form a proper soil. It remains, however, to be determined, what is the due proportion of these ingredients for forming a proper soil.

“ We know that neither chalk, nor marl, nor lime, can be made to nourish plants alone ; and soils are sometimes found that abound with the two first of these to a faulty degree. But the proportion of calcareous matter in these is so much larger than could ever be produced by art, where the soil was naturally destitute of these substances, that there seems to be no danger of erring on that side. Probably it would be much easier to correct the defects of those soils in which calcareous matters superabound, by driving earth upon them as a manure, than is generally imagined ; as a very small proportion of it sometimes affords a very perfect soil. I shall illustrate my meaning by a few examples.

“ Near Sandside, in the county of Caithness, there is a pretty extensive plain on the sea coast, endowed with a most singular degree of fertility. In all seasons it produces a most luxuriant herbage, although it never got any manure since the creation ; and has been from time immemorial subjected to the following course of trops.

- “ 1. Bear, after once ploughing from grass, usually a good crop.
- “ 2. Bear, after once ploughing, a better crop than the first.
- “ 3. Bear, after once ploughing, a crop equal to the first.

“ 4. 5.

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tion.

“ 4. 5. and 6. Natural grass, as close and rich as could be imagined, might be cut, if the possessor so inclined, and would yield an extraordinary crop of hay each year.

“ After this the same course of cropping is renewed. The soil that admits of this singular mode of farming, appears to be a pure incoherent sand, destitute of the smallest particle of vegetable mould; but, upon examination, it is found to consist almost entirely of broken shells: the fine mould here bears such a small proportion to the calcareous matter, as to be scarce perceptible, and yet it forms the most fertile soil that ever I yet met with.

“ I have seen many other links (downs) upon the sea shore, which produced the most luxuriant herbage, and the closest and sweetest pile of grass, where they consisted of shelly sand; which, without doubt, derive their extraordinary fertility from that cause.

“ A very remarkable plain is found in the island of Jir-eye, one of the Hebrides. It has been long employed as a common: so that it has never been disturbed by the plough, and affords annually the most luxuriant crop of herbage, consisting of white clover and other valuable pasture grass, that can be met with anywhere. The soil consists of a very pure shelly sand.

“ From these examples, I think it is evident, that a very small proportion of vegetable mould is sufficient to render calcareous matter a very rich soil. Perhaps, however, a larger proportion may be necessary when it is mixed with clay than with sand; as poor chalky soils seem to be of the nature of that composition.”

To these examples brought by Dr Anderson, we may add some of the same kind mentioned by Lord Kaimes.

Kaines. His lordship having endeavoured to establish Principles of Cultivation, though he himself frequently deviates from that theory, yet thinks it possible, upon such a principle, to make a soil perpetually fertile.

" To recruit (says he), with vegetable food, a soil impoverished by cropping, has hitherto been held the only object of agriculture. But here opens a grander object, worthy to employ our keenest industry, that of making a soil perpetually fertile. Such soils actually exist; and why should it be thought, that imitation here is above the reach of art? Many are the instances of nature being imitated with success. Let us not despair while any hope remains; for invention never was exercised upon a subject of greater utility. The attempt may suggest proper experiments: it may open new views: and if we fail in equalling nature, may we not, however, hope to approach it? A soil perpetually fertile must be endowed with a power to retain moisture sufficient for its plants, and at the same time must be of a nature that does not harden by moisture. Calcareous earth promises to answer both ends; it prevents a soil from being hardened by water; and it may probably also invigorate its retentive quality. A field that got a sufficient dose of clay marl, carried above 30 successive rich crops, without either dung or fallow. Doth not a soil so meliorated draw near to one perpetually fertile? Near the east side of Fife, the coast for a mile inward is covered with sea sand, a foot deep or so; which is extremely fertile, by a mixture of sea shells reduced to powder by attrition. The powdered shells, being the same with shell marl, make the sand retentive of moisture; and yet no quantity of moisture

will

~~Principles will unite the sand into a solid body. A soil so mixed
in Cultivation seems to be not far distant from one perpetually fertile.~~
 These, it is true, are but faint essays; but what will not perseverance accomplish in a good cause?"

Inconsistency in Lord
Kaimes's
theory.

Having thus, in a manner, positively determined with Dr Anderson, that no dose of calcareous matter can possibly be too great, we cannot help owning ourselves surprised on finding his lordship expressing himself as follows: "An overdose of shell marl, laid perhaps an inch, and an inch and a half, or two inches thick, produces, for a time, large crops: but at last it renders the soil a *caput mortuum*, capable of bearing neither corn nor grass; of which there are too many instances in Scotland. The same probably would follow from an overdose of clay marl, stone marl, or pounded lime-stone." To account for this, he is obliged to make a supposition directly contrary to his former one; namely, that calcareous matter renders the soil *incapable* of retaining water. This phenomenon, however, we think is solved upon the principles above laid down, in a satisfactory manner, and without the least inconsistency.

Perpetual
fertility of
such change-
able

As to rendering soils perpetually fertile, we cannot help thinking the attempt altogether chimerical and vain. There is not one example in nature of a soil perpetually fertile, where it has no supply but from the air and the rain which falls upon it. The above recited examples can by no means be admitted as proofs of perpetual fertility. We know, that the grass on the banks of a river is much more luxuriant than what grows at a distance: the reason is, that the water is attracted by the earth, and communicates its fertilizing qualities to it; but was the river to be dried up, the grass

grafts would soon become like the rest. Why should Principles of Cultivation.
not the ocean have the same power of fertilizing plains near its shores, that rivers have of fertilizing small spots near their banks? We see, however, that it hath not: for the sea shores are generally sandy and barren. The reason of this is, that the waters of the ocean contain a quantity of loose acid; and this acid is poisonous to plants: but, abstracting this acid part, we hesitate not to affirm, that sea water is more fertilizing than river water. It is impossible to know how far the waters of the ocean penetrate under ground through a sandy soil. Where they meet with nothing to absorb their acid, there the ground is quite barren; but in passing through an immense quantity of broken shells, the calcareous matter will undoubtedly absorb all the superfluous acid; and thus the soil will be continually benefited by its vicinity to the ocean. All the above fields, therefore, are evidently supplied with nourishment from the ocean: for if the salt water has sufficient efficacy to render fields which are in its neighbourhood barren, why should it not, like other water, render them fertile when the cause of barrenness is removed from it?

After all, the field in Caithness, mentioned by Dr Anderson, seems to have been perpetually fertile only in grafts; for though the second year it carried a better crop of bear than it did the first, yet the third year the crop was worse than the second, and only equal to the first. Had it been ploughed a fourth time, the crop would probably have been worse than the first. Ground is not near so much exhausted by grafts as corn, even though the crop be cut and carried off; and still less if it only feeds cattle, and is manured by their dung; which appears to have been the case with this field.

*Principles
of Cultiva-
tion.* Lord Kames, indeed, mentions fields in Scotland, that, past memory, have carried successive crops of wheat, pease, barley, oats, without a fallow, and without manure; and particularizes one on the river Carron, of nine or ten acres, which had carried 103 crops of oats without intermission and without manure: but as we are not acquainted with any such fields, nor know anything about their particular situation, we can form no judgment concerning them.

*Soils im-
proved by
mixture.*

Defective soils are sometimes improved by being mixed with each other. Thus clay, or a soil chiefly formed of that ingredient, is apt, as formerly noticed, to be hardened by the heat of the sun, so that the vegetables can scarce penetrate it in such a manner as to receive proper nourishment. Sand, on the contrary, if it is not situated so as to receive a great deal of moisture, is very apt to be parched up in summer, and the crop destroyed; nor has it sufficient adhesion to support plants that have few roots and grow high. From these opposite qualities, it is evident that these two soils would be a proper manure for one another: the clay would give a sufficient degree of firmness to the sand, and the sand would break the too great tenacity of the clay. According to Dr Home's experiments, however, sand is the worst manure for clay that can be used. He recommends marl most. To reduce clay ground as near as possible to the form of pure vegetable mould, it must first be pulverized. This is most effectually performed by ploughing and harrowing; but care must be taken not to plough it whilst too wet, otherwise it will concrete into hard clods which can scarcely be broken. After it is pulverized, however, some means must be taken to keep it from concreting again into the same hard masses as before.

According

According to Lord Kaines, though clay, after pulverization, will concrete into as hard a mass as before, if mixed with water; yet if mixed with dunghill juice, it will not concrete any more. Lime also breaks its tenacity, and is very useful as a manure for this kind of soil.

The conclusion, however, which we wish the practical Fertility of farmer to draw from our theory is, That there is a certain ^{the earth limited.} limit to the fertility of the earth, both as to duration and to degree, at any particular time: that the nearer any soil approaches to the nature of pure garden mould, the nearer it is to the most perfect degree of fertility; but that there are no hopes of keeping it perpetually in such a state, or in any degree of approximation to it, but by constant and regular manuring with dung. Lime, chalk, marl, &c. may be proper to bring it near to this state, but are absolutely unfit to keep it continually so. They may indeed for several years produce large crops; but the more they increase the fertility for some years, the sooner will they bring on an absolute barrenness; while regular manuring with plenty of dung will always ensure the keeping up the soil in good condition, without any occasion for fallow. What we have said concerning the use of lime, &c. applies likewise to the practice of frequent ploughing, though in a less degree. This tends to meliorate ground that is naturally poor, by giving an opportunity to the vegetable parts to putrefy; but when that is done, it tends to exhaust, though not so much as lime. A judicious farmer will constantly strive to keep his lands always in good condition, rather than to make them suddenly much better; lest a few years should convince him that he was in reality doing almost irre-

Principles parable mischief, while he fancied himself making improvements. As for the ridiculous notions of stimulating the ground by saline manures, for the purpose of exciting it to perpetual fertility, we hope they will never enter the brain of any rational practitioner of agriculture.

In addition to what is here stated, however, concerning the distinction of soils in general, it may be necessary to take notice of the manner in which, with a practical view, they have usually been discriminated by agricultural writers. This is the more necessary, on account of the frequent recurrence of various denominations of soil in treatises upon this important subject, the use of which, from the want of a scientific nomenclature, it will not be entirely in our power to avoid. Mr Young remarks, that in some parts of England where husbandry is successfully practised, any loose clay is called marl, in others marl is called chalk, in others clay is called loam. To avoid increasing this confusion, we shall here follow the practical description of soils given by the celebrated chemist Richard Kirwan, Esq. previously observing, that by calcareous earth, is meant chalk and all stones that burn to lime, effervesing in their natural state with all acids. Argil is pure clay, which forms alum with the vitriolic acid, but scarcely effervesces with any of the acids. Siliceous earth is flint or pure sand, such as that whereof glass is made; it effervesces with no acid. We may add that ferruginous earth, or iron, is the cause of the red or brown colour that appears in many soils.

"The soils most frequently met with, says Mr Kirwan, and which deserve a distinct consideration, are clay, chalk, sand, and gravel, clayey loam, chalky loam, sandy loam, gravelly loam, ferruginous loam,

boggy soil, and heathy soil, or mountain as it is often called.

“ Clay is of various colours ; for we meet with white, gray, brownish red, brownish black, yellowish, or bluish clays ; it feels smooth, and somewhat unctuous ; if moist, it adheres to the fingers, and if sufficiently so, it becomes tough and ductile ; if dry, it adheres more or less to the tongue ; if thrown into water it gradually diffuses itself through it, and slowly separates from it. It does not usually effervesce with acids, unless a strong heat be applied, or that it contains a few calcareous particles or magnesia. If heated, it hardens, and burns to a brick.

“ It consists of argil and fine sand, usually of the siliceous kind, in various proportions, and more or less ferruginous. The argil forms generally from 20 to 75 per cwt. of the whole mass, the sand and calx of iron the remainder. These are perfectly separable by boiling in strong vitriolic acid.

“ Chalk, if not very impure, is of a white colour, moderate consistence, and dusty surface ; stains the fingers ; adheres slightly to the tongue ; does not harden when heated, but on the contrary, in a strong heat, burns to lime, and loses about $\frac{1}{2}$ of its weight. It effervesces with acids, and dissolves almost entirely therein. I shall also add, that this solution is not disturbed by caustic volatile alkali, as this circumstance distinguishes it from magnesia. It promotes putrefaction.

“ Sand.—By this is meant small loose grains of great hardness, not cohering with water nor softened by it. It is generally of the siliceous kind, and therefore insoluble in acids.

“ Gravel differs from sand chiefly in size ; however,

Principles of Cultivation. Stones of a calcareous nature, when small and rounded, are often comprehended under that denomination.

“ Loam denotes any soil moderately cohesive, that is, less so than clay, and more so than loose chalk ; by the author of the Body of Agriculture it is said to be a clay mixed with sand. Dr Hill defines it an earth composed of dissimilar particles, hard, stiff, dense, harsh and rough to the touch, not easily ductile while moist, readily diffusible in water, and composed of sand and a tough viscid clay. The definition I have given, seems most suited to the different species I shall now enumerate.

“ Clayey loam denotes a compound soil, moderately cohesive, in which the argillaceous ingredient predominates ; its coherence is then greater than that of pure clay ; the other ingredient is a coarse sand, with or without a small mixture of the calcareous ingredient. It is this which farmers generally call *strong, stiff, cold, and heavy* loam, in proportion as the clay abounds in it.

“ Chalky loam. This term indicates a loam formed of clay, coarse sand, and chalk ; in which, however, the calcareous ingredient, or chalk, much predominates. It is less cohesive than clay loams.

“ Sandy loam, denotes a loam in which sand predominates. It is less coherent than either of the above mentioned. Sand, partly coarse, and partly fine, forms from 80 to 90 per cwt. of this compound.

“ Gravelly loam differs from the last, only in containing a larger mixture of coarse sand or pebbles. This and the two last are generally called by farmers *light* or *hungry* soils ; particularly when they have but little depth.

“ Ferruginous loam, or till. This is generally of a dark brown or reddish colour, and much harder than

any

any of the preceding. It consists of clay and calces of iron, more or less intimately mixed. It may be distinguished not only by its colour, but also by its superior weight. It sometimes effervesces with acids and sometimes not; when it does, much of the iron part may be separated, by pouring it when well dried into spirit of salt, from which the iron may be separated by alkalies or chalk.

“ Akin to this are certain *vitrific soils*, which, when steeped in water, impart to it the power of reddening syrup of violets. These are generally of a blue colour, but redden when heated.

“ Boggy soil, or bogs, consist chiefly of ligneous roots of decayed vegetables mixed with earth, mostly argillaceous, and sand, and a coaly substance derived from decayed vegetables. Of bogs there are two sorts: the black, which contains a large proportion of clay and of roots more perfectly decayed, with mineral oil; in the red, the roots seem less perfectly decayed, and to form the principal part.

“ Heathy soil, is that which is naturally productive of heath.”

Though not properly a kind of soil, yet, as used for the purpose of improving other soils, we may here take notice of the description given by the same writer of what is called *marl*. “ Marl is of three sorts, calcareous, argillaceous, and siliceous or sandy. All are mixtures of mild calx (i. e. chalk) with clay, in such a manner as to fall to pieces by exposure to the atmosphere, more or less readily.

“ Calcareous marl is that which is most commonly understood by the term *marl without addition*. It is generally of a yellowish white, or yellowish gray colour;

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of Cultiva-
tion.* rarely brown or lead coloured. It is seldom found on the surface of land, but commonly a few feet under it, and on the sides of hills or rivers that flow through calcareous countries, or under turf in bogs, frequently of a loose texture, sometimes moderately coherent, rarely of a stony hardness, and hence called *stone-marl*; sometimes of a compact, sometimes of a lamellar texture, often so thin as to be called *paper-marl*. It often abounds with shells, and then is called *shell-marl*, which is looked upon as the best sort. When in powder, it feels dry between the fingers; but in water, it quickly falls to pieces or powder, and does not form a viscid mass. It chips and moulders by exposure to the air and moisture, sooner or later, according to its hardness and the proportion of its ingredients. If heated, it will not form a brick, but rather lime. It effervesces with all acids. It consists of from 33 to 80 per cwt. of mild calx, and from 66 to 20 per cwt. of clay.

" To find its composition, pour a few ounces of weak, but pure, spirit of nitre or common salt, into a Florence flask; place them in a scale, and let them be balanced; then reduce a few ounces of dry marl into powder, and let this powder be carefully and gradually thrown into the flask, until, after repeated agitation, no effervescence is any longer perceived; let the remainder of the powder marl be then weighed, by which the quantity projected will be known: let the balance be then restored; the difference of weight between the quantity projected and that requisite to restore the balance, will discover the weight of air lost during the effervescence; if the loss amounts to 13 per cwt. of the quantity of marl projected, or from 13 to 12 per cwt. the marl essayed is calcareous marl.

This

This experiment is decisive, when we are assured by the external characters above mentioned, that the substance employed is marl of any kind; otherwise, some sorts of the sparry iron-ore may be mistaken for marl. The experiments to discover the argillaceous ingredient, being too difficult for farmers, I omit. The residue left after solution being well washed will, when duly heated, generally harden into a brick.

" Argillaceous marl contains from 68 to 80 per cwt. of clay, and consequently from 32 to 20 per cwt. of aerated calx. Its colour is gray, or brown, or reddish brown, or yellowish or bluish gray; it feels more unctuous than the former, and adheres to the tongue; its hardness is generally much greater; in water it falls to pieces more slowly, and often into square pieces; it also more slowly moulders by exposure to the air and moisture, if of a loose consistence; it hardens when heated, and forms an imperfect brick; it effervesces with spirit of nitre or common salt, but frequently refuses to do so with vinegar; when dried and projected into spirit of nitre, in a Florence flask, with the attentions above mentioned, it is found to lose from 8 to 10 per cwt. of its weight. The undissolved part well washed, will, when duly heated, harden into a brick.

" Siliceous or sandy marls are those whose clayey part contains an excess of sand; for, if treated with acids, in the manner above mentioned, the residuum or clayey part will be found to contain above 75 per cwt. of sand; consequently chalk and sand are the predominant ingredients.

" The colour of this marl is brownish gray or lead colour; generally friable and flaky, but sometimes forms very

Fertilizing very hard lumps; it does not readily fall to pieces
^{Plants.} in water; it chips and moulders by exposure to the air and moisture, but slowly; it effervesces with acids, but the residuum after solution will not form a brick.
 "Lime-stone gravel. This is a marl mixed with large lumps of lime-stone; the marl may be either calcareous or argillaceous, but most commonly the former; the sandy part is also commonly calcareous."

We shall discuss particularly the special modes of ameliorating, by proper mixtures and additions, these several kinds of soil, when we come afterwards to treat of the practical preparation and use of manures in husbandry.

SECT. V.

OF THE DIFFERENT KINDS OF VEGETABLES PROPER TO BE RAISED WITH A VIEW TO THE MELIORATION OF SOIL.

Soil improv- THE cultivation of certain plants, when properly conducted, has a considerable tendency to increase the fertility of the soil. In such a case the farmer enjoys the satisfaction of meliorating his lands, and of reaping crops at the same time.

One very considerable step towards the melioration of ground is its pulverization. This is usually accomplished by repeated ploughings, and more particularly by the use of summer fallow; which latter practice consists of allowing the soil to remain without a crop for a whole season, and during that time of repeatedly turning it over with the plough.

plough. In the French husbandry, as already mentioned, to this day, the summer fallow is almost the only resource that is employed to render the soil capable of bearing successive crops of grain; and the same practice anciently prevailed in our own country, and even continues to prevail to a great extent.

It is undoubtedly true, that under a rotation, consisting of summer fallow and crops of grain alternately, the land has not been found to improve; but, it is also true, that upon certain soils, when the cropping was not severe, the land continued, with little other aid than that of summer fallow, to produce grain during a great length of time, without any sensible deterioration. The benefits which the use of fallow confers upon the soil, or the advantages which the husbandman derives from it, appear to be chiefly these: it pulverizes, cleans, and manures, the soil. In the first place, as already mentioned, it pulverizes the soil, and breaks that tenacity of parts which, in its rude state, it naturally acquires, and thereby enables the roots of delicate plants to pervade it freely in all directions in quest of their natural nourishment. From the nature of the thing, however, it is obvious, that repeated ploughings (especially when performed in autumn, with a view to expose the soil to the pulverizing effects of the winter's frost), must be chiefly valuable upon lands of a stiff and adhesive texture, and that upon light and sandy soils it will be less necessary. Accordingly it has been found by experience, that such soils have been very perceptibly injured by too frequent ploughings. It is no doubt true, that all plants require a certain openness to be preserved in the earth around their roots, that they may be enabled to push out with advantage; but it is also

Fertilizing also necessary that the soil should possess such a degree of firmness as may enable it to retain, for a sufficient length of time, the moisture requisite for the support of vegetation; and, at the same time, afford a steady support to the stems of the plants which grow upon it.

The second use of summer fallow consists of its tendency to clear the ground from those other plants which we wish to destroy for the purpose of making room for the vegetables that we would wish to rear, as most valuable, for the support of men or cattle. The destruction of noxious plants is accomplished by summer fallowing in two ways: 1st, By its effect upon the roots of such plants; and, 2dly, by its effects upon the seed. Nature has provided very carefully and effectually for the preservation of most of her vegetable productions, by rendering them capable of propagating themselves in two ways—either by the seed, or, if that is not suffered to arrive at maturity, by putting forth new stems from the roots. By means of summer fallow both these modes of reproduction are, in some measure, counteracted. The roots of the plants we wish to destroy being turned up, and exposed to the action of the sun and air, are rendered unfit for vegetation. The seeds of plants are in general so well protected by the kind of covering in which they are enveloped, as to remain long indestructible by exposure to the air; but, being suffered to vegetate, and at the same time ploughed down before they are allowed to ripen or bring forth new seed, they also are destroyed by the frequent stirring of the land for which a summer fallow affords an opportunity.

A third and last advantage derived from summer fallow

low, consists of its effect in ameliorating or enriching ^{Fertilizing} ~~the~~ ^{Plants} soil. That the use of summer fallow must confer something nutritive, or some kind of manure upon the land, seems demonstrable. During the old system of husbandry, many soils received little other amelioration than what they derived from a summer fallow; yet for ages they continued to produce a certain quantity of grain, which was carried off from the lands, and consumed at a distance, without any care being taken to give to the soil a compensation for what it had thus lost. While this practice prevailed, it was found that no number of ploughings, even where the land was tolerably clean, could produce the effect of a summer fallow, or enable the land to bear a tolerable crop without the kind of amelioration which that practice conferred.

That a summer fallow tends actually to enrich, or, in the strict sense of the word, to add manure to the soil, seems obvious. By exposing to the air the roots of the various plants, whether of natural or artificial growth, with which the soil abounds, it converts these roots into a source of new fertility. By the action of the air and of light they suffer a chemical decomposition, which is analogous to fermentation, and which ends in the production of a portion of fertile soil or garden mould. It is probably in consequence of this change which the roots of plants undergo, or their rotting, that land turned up by the plough soon acquires a darker colour than it formerly possessed.

It does not appear, however, that the manure obtained in this way from the decayed roots of vegetables, will entirely account for the fertilizing effects of a summer fallow, or that a sufficient compensation is thus made to the soil for what is lost by a previous crop. It is

Fertilizing is probable, therefore, that the earth itself when turned up, attracts or absorbs from the light, and from the air some fertilizing principles. We are still too little acquainted with the laws which govern the circulation of the different elements of nature, to be able to explain precisely and clearly the kind of change which is thus operated. It is certain that all putrid effluvia are rapidly absorbed, or putrid substances deprived of their smell, by fresh earth or mould; and it is probable that as cultivated countries are the most healthful, the soil when newly stirred or turned up, has a tendency speedily to withdraw from the atmosphere all bad air, or the great quantities of volatile or carbonaceous matter thrown into it by the respiration of animals or artificial combustion.

The practice of summer fallow, however, for the purpose of ameliorating the soil, is attended with immense disadvantages. That a third or a fourth of the whole arable territory of a state should annually remain not merely unproductive, but a source of expence from the frequent ploughings it requires, is undoubtedly a very serious evil;—to landlords, as occasioning a proportional inferiority of rent; to farmers, as lessening the profit of their occupation; and to the nation, as implying a slender population, in consequence of the scantiness of the produce of its territory. Hence it has always appeared an important object in agriculture, to diminish as far as possible the quantity of fallows, without injuring the productive energies of the soil. Here modern husbandry enjoys one of its greatest triumphs over ancient practices, by introducing certain crops, which perform to the land and to the husbandman the three services already ascribed to fallows, of pulverizing, cleaning,

is, and manuring the soil, while at the same time a ^{Fertilizing} great additional quantity of food is produced for man or cattle.

By planting in the field those vegetables whose roots swell to a considerable bulk, the ground must constantly be acted upon by the swelling of their roots in all directions : and thus the growing of the crop itself may be equal, or superior, in efficacy to several ploughings, at the same time that the farmer enjoys the benefit of it. The plant most remarkable for the swelling of its roots is the potato, though it undoubtedly exhausts the productive powers of the soil in a very great degree. Potatoes are not, however, equally proper for all soils. In clay they do not thrive, nor are palatable ; but in gravelly or sandy soils, they grow to a large size, and are of an excellent quality. Turnips likewise contribute to loosen the soil by the swelling of their roots, though not so much as potatoes. They have this advantage, however, that they will thrive in almost any soil. In clay ground, peas and beans thrive exceedingly well, and therefore are proper in this kind of soil as a preparatory for other kinds of grain. These push their roots deep into the ground, and cover it with their leaves more than other crops ; so that the sun has not so much access as when it is covered with other kinds of grain. Wherever any of these kinds of vegetables are raised, it is observable, that more or less blackness is communicated to the soil : an evident sign of its melioration ; this being the colour of the true vegetable mould, or rich *loamy soil*, as it is often called.

Besides the above-mentioned plants, carrots, parsnips, cabbages, and all those vegetables which sink their roots deep into the ground, answer the same purpose of loosening

Fertilizing ^{Plants.} loosening and pulverizing the earth: but as they will not thrive but on ground already well cultivated, they cannot be raised to any advantage upon a poor soil.

Most of the same vegetables, by means of the drill husbandry, that is, by being planted in rows which admit the earth to be freely stirred by the plough about their roots while the plants are growing, afford an opportunity of clearing the soil of weeds to no less advantage than can be obtained by the costly operation of a summer fallow. Nay it is even found, that while one farmer, by means of these green crops, frequently ploughed in the intervals, or between the rows, reduces his lands to the state of a garden, both in point of pulverization and cleanliness, his neighbour, trusting to the old summer fallow, in spite of all his labour and expence, finds annual weeds gaining ground upon him apace, and has no other resource than that of laying down his fields to grass for some years.

When the plants already mentioned are used upon a farm instead of fallow, and when they are employed for feeding cattle, they afford an opportunity of ameliorating the soil in a far higher degree than could ever be accomplished by means of summer fallow. If the dung thus produced is properly managed, it not only prevents the deterioration of the most ordinary soil, but gradually carries it forward in a state of progressive improvement, and it is only by the extension of the system of raising green crops or crops of roots instead of fallow, and by feeding cattle upon the farm with the produce, that we can expect to see the distinction between what is called in-field and out-field land completely abolished, and the whole arable waste lands of the kingdom profitably brought under the plough.

It

It has been customary in many places, particularly Fertilizing Plants. in England, to sow turnips, pease, buck-wheat, &c. and then to plough them down for manuring the land. This being similar to that operation of nature by which she renders uncultivated soils so exceedingly fertile, cannot fail of being attended with singular advantages; and might be looked upon as preferable even to driving dung on the land to fatten it, were it not attended with the entire loss of a crop for that year.

Attempts have indeed been made to avoid the loss of a crop in such cases. These attempts well deserve the attention and approbation of agriculturists, and we regret that their general practicability has not yet been sufficiently established in our climate. A correspondent of Mr Young* tried successfully to raise a crop of turnips after ploughing down a crop of buck-wheat which had been raised during the same season. "This year I have the pleasure to inform you, (says this gentleman, Colonel Vavasour), that I have made trial of turnips after buck-wheat ploughed in on the second week of July. The buck-wheat was sown the second week of May, upon four acres of very light land that had been marled the former summer. The turnips are a very good crop; I think the best in our neighbourhood.

"The making turnips succeed buck-wheat ploughed in I most earnestly recommend to farmers on light land who have a difficulty in procuring manure; and upon strong heavy lands that have been long under the plough, and subjected to the old husbandry, viz. two crops and a fallow.

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* *Annals of Agriculture*, vol. xxxii.

Fertilizing Plants. "I do not know any crop like buck-wheat ploughed in as a preparative for winter corn : I have a field of strong land under this husbandry of wheat sown the end of September after buck-wheat ploughed in. At present its appearance promises to be a good crop ; and it seems to me reasonable, that a heavy crop of vegetable matter ploughed into land that has been long under tillage in the old way of husbandry above mentioned, must greatly refresh the soil. A heavy crop of buck-wheat is certain to be procured on strong clay land well pulverized in the month of June, provided the summer proves tolerably dry after the seed is sown.

"And now, after recommending turnips on buck-wheat ploughed in, I do not know a better way to lay down light land to permanent grass, than to let buck-wheat in the month of June, with grass seeds, follow turnips. I mean the roota baga, which will remain good for sheep all the month of May, or longer, if other provision should be scarce.

"I laid down a field three years ago to permanent grass with buck-wheat sown the end of June and harvested the end of September. This mode has many advantages which must occur to every practical farmer. The grass seeds came up well."

In addition to this, it may be proper to remark, that an idea has been entertained with regard to the succession of vegetables to each other, which ought not to be overlooked, as at some future period it may lead to important consequences. It has been supposed, that the roots of plants, or at least of some plants, possess a power of throwing out, as excrementitious, a part of the substances which they have taken in, but which are no longer necessary for their subsistence or growth.

It

It is undoubted, at least, that while by some plants the soil seems to be rendered altogether unfit for the production of certain others, it is rendered by different plants extremely well adapted to their growth. Thus wheat succeeds uncommonly well after drilled beans; and these two vegetables have even been repeated for a great number of years in rotation, without any deficiency or failure of crop.

SECT. VI.

OF DESTROYING WEEDS.

WHAT we have already said regarding the cultivation of the soil, respects only the fitting it for producing all kinds of vegetables indiscriminately. Experience, however, shows, that the ground is naturally much more disposed to produce and nourish some kinds of vegetables than others; and those which the earth seems most to delight in, are commonly such as are of very little use to man; but if neglected, will increase to such a degree, as entirely to destroy the plants intended to be raised, or at least hinder them from coming to perfection, by depriving them of nourishment. The clearing the ground of weeds, therefore, is an article no less necessary in agriculture, than the disposing it to produce vegetables of any kind in plenty.

Weeds may be divided, according to the time of their duration, into *annual*, or such as spring from a seed, and die the same year; and *perennial*, that is,

Of Destroy-such as are propagated by the seeds, and last for a
ing Weeds number of years. The first kind are the least noxious, and most easily destroyed. For this purpose it will be sufficient to let them spring up till near the time of ripening their seed, and then plough them down before it comes to maturity. This was formerly done by means of a summer fallow, as already mentioned, but may be performed more advantageously by green crops carefully horse-hoed. It is also of service to destroy such weeds as grow in borders or neglected corners, and frequently scatter their seeds to a great distance; such as the thistle, dandelion, rag-weed, &c. for these are sufficient to propagate their species through a deal of ground; as their seeds are carried about with the wind to very considerable distances. A farmer ought also to take care, that the small seeds of weeds, separated from corn in winnowing, be not sown again upon the ground; for this certainly happens when they are thrown upon a dunghill; because, being the natural offspring of the earth, they are not easily destroyed. The best method of preventing any mischief from this cause, would be to burn them.

Perennial weeds, how destroyed. Perennial weeds cannot be effectually destroyed, but by removing the roots from the ground, which is often a matter of some difficulty. Many of these roots strike so deep in the ground, that they can scarcely be got out. The only method that can be depended upon in this case, is frequent ploughing, to render the ground as tender as possible; and harrowing with a particular kind of harrow, which shall hereafter be described, in order to collect these pernicious roots. When collected, they ought to be dried and burnt, as the only effectual

factual method of ensuring their doing no further mis-^{Of Destroy-}
chief.^{ing Weeds}

There is a particular species of weed, peculiar only to grass lands, of a soft spongy nature, called *fog*, which it is found very difficult to exterminate.

What is vulgarly called fog uniformly consists of one or more species of what are properly denominated the *moss* plants. The nature of these plants, and consequently of fog, will be fully explained when we come to treat of the subject of mosses, and their improvement. In the mean time it may be remarked, that the moss plants are extremely hardy in their nature, and grow up readily upon poor soils in all such cold and bleak situations as are unfit for the permanent production of more delicate plants. When lands, therefore, have been laid down to grass in a poor and exhausted state, the grasses die out in a few years, and their place is occupied by various species of the hardy moss plants under the denomination of fog, which is unfit for the sustenance of cattle. The proper mode of exterminating this weed upon arable lands consists of using the plough for the purpose of putting them under one or more crops of turnips. If the turnips are eaten upon the field by cattle or sheep, the soil will necessarily be enriched by their dung, but if these roots are conveyed to cattle intended to be stall-fed, the cattle's dung ought to be entirely laid upon the field. In either case the soil thus enriched may again be laid down to grass.

In the case of high or upland pastures that are not arable, the best mode of permanently destroying fog or the moss plants, and of encouraging the growth of the more delicate grasses, consists of improving the climate

Of Destroying by belts of planting, and at the same time of spreading
~~long Weeds.~~ upon the surface of the soil quick-lime, which is a deadly
foe to all the most plants, and consequently to fog.

Mr Young* mentions a mode of temporarily destroying fog, which deserves notice on account of the facility of the practice, and the advantages with which it is attended.

" Many years past, (says this author), the late Reverend Mr Lord of Welneyham, in Suffolk, practised a husbandry which I have often heard farmers condemn; it was that of keeping for winter use the whole crop of grass. I have seen him thus preserve what would in July have produced two tons of hay per acre. I did not then approve the practice, and urged theoretically, that the plants perfecting their seeds, and standing long after, must become mere straw, and of no value; he replied that it should be what I pleased to call it *straw*, if I would have it so; but that he found this straw mixed, as it will be, with a young growth, better than hay. I once ordered a field to be kept in like manner; but my bailiff, disliking much the experiment, in my absence turned cattle in, and fed it the latter end of August or beginning of September. It now appears to be no uncommon practice in South Wales. The account we have of it is very curious: On uplands, so dry and found that no animal can, in the wettest weather, make an impression on the surface, and naturally running to white-clover and good grass, it is the practice to set apart many acres. Early in May the fields are shut up for the summer season with no other

* *Agricultural Magazine*, vol. xxii.

other attention than to cut docks and thistles, and thus Of Destroying Weeds, left till December, when all the stock is turned in, and ~~the~~ all sorts are kept in excellent condition without any hay, straw, or other food ; and the butter thus gained as good as in any part of the year. The frost sweetens the grass, and snow does not injure it ; but while it is buried, dry food is given. Early in spring there is under this shelter a great growth of young grass ; and both together eaten with avidity. Moss is thus cured, and disappears without the aid of the plough or manure. It betters every year ; and the best acre of hay will not keep more stock, or in such good condition, as an acre of fog. The fields are found to be much improved by the quantity of seeds that fall. It appears that the practice is found in the west riding of Yorkshire ; but they do not train up till the beginning of July."

Besides these kinds of weeds, which are of an herba-
ceous nature, there are others which are woody, and grow to a very considerable size ; such as broom, furze, &c. *Broom*, *furze*, &c. how de-
stroyed. or whins, and thorns. *Broom* is an evergreen shrub, that thrives best in a sandy soil ; and there it grows so vigorously, as scarcely to admit any grass under it. It propagates by seed which grows in pods ; and these, when fully ripe, break with violence, scattering the seeds all around. Thus, a field which is overgrown with broom, besides the old plants, always contains an infinite number of young ones : so that though the old plants die when cut over, a fresh crop constantly springs up. It may, however, be destroyed by frequent ploughing and harrowing, in the same manner as other perennial weeds are ; for it does not for some time carry any seed, and the frequent ploughing encourages the vegetation of all those seeds that are already in the

Of Destroy-ground, which cannot fail of being destroyed by frequent repetitions of the operation. Another method of destroying broom, is by pasturing the field where it grows with sheep. A few of the old bushes may be left as a shelter, and these will be in a good measure prevented from spreading by the cropping of the sheep. These animals are very fond of broom, and greedily devour every young shoot; so that if any remain after the first year, there will not be a vestige the second. If this method of extirpating broom is equally effectual with that of frequent ploughing, it is certainly much more profitable, as there is no food more nourishing to sheep than young broom. Broom, however, is said to have a singular effect upon sheep: it makes them drunk so effectually, that when heated with a little driving, they tumble over, and lie without motion.

The *whin* is a fine evergreen shrub, carrying a sweet-smelling flower all the year round. It propagates both by seed and by its roots, which spread sometimes to the distance of 10 or 12 feet; and hence, when once established, it is with difficulty extirpated. The best method is to set fire to the whins in frosty weather; for frost has the effect to wither whins, and make them burn readily. The stumps must then be cut over with a hatchet: and when the ground is well softened by rain, it may be ploughed up, and the roots taken out by a harrow adapted to that purpose. If the field is soon laid down to grass, the whins will again spring up in great abundance from the seeds, and small parts of the roots left in the ground. In this case, pasturing with sheep is an effectual remedy; as they are no less fond of young whins than of young broom; and if there are a sufficient number, they will not leave a single plant

plant above ground. But if grass is not immediately wanted, the most effectual method of clearing a field ~~of whins,~~ is by reiterated ploughings.

The *thorn*, or *bramble*, spreads its roots very wide, and at the same time sinks them deep in the earth. Though cut in the winter, it rises, and comes to such perfection as to carry fruit in summer. It can only be extirpated by ploughing up the ground, and collecting the roots.

One effectual plan, which, as will afterwards appear, is practicable in many more situations than it has hitherto been applied to, for destroying these and all other woody shrubs and plants, together with a great number of weeds that are of no value upon pasture grounds, consists of flooding the land, by directing over it a stream of water. By means of such a device, all whins and other shrubs are completely rotted and destroyed.

SECT. VII.

OF THE DISEASES OF PLANTS.

As some of the most valuable kinds of vegetables are liable to suffer much by diseases peculiar to themselves, it is of much importance to the husbandman to be aware of this circumstance, and to adopt every known mode of protecting his crop against them. At the same time, as the principles of vegetable life are by no means well understood, the causes and the cure of the most serious diseases affecting plants still remain

Diseases of main under a great degree of obscurity, and the most Plants. experienced and intelligent husbandmen express great uncertainty respecting the measures to be adopted for preventing their appearance. Hence it seems most proper, to introduce the consideration of them in this place before we proceed to the practical part of the subject; and as wheat is accounted the most valuable kind of grain, we shall begin with the diseases to which it is exposed.

Diseases to
which
wheat is
liable.

Blight in
1795.

Wheat chiefly suffers from two diseases, the blight and the mildew. Of the blight in wheat we shall give an account upon the authority of an essay by Robert Somerville, Esq. surgeon, 1st Battalion, 8th Fencible Regiment, inserted in the communications to the Board of Agriculture *, giving a statement of the nature and appearance of the blight which occasioned the failure of the crop in 1795. When the crop had just shaken the flowers, and the grains were beginning to form, most of them seemingly in a healthy manner, it was observed that many of the blades and stalks were rather of a dirty green colour, and in two weeks thereafter there appeared upon them great numbers of small red insects. As the season advanced, these insects not only increased in size, but became more numerous, and in almost every field the grain began to manifest unequivocal symptoms of disease, which were so formidable, that, in many instances, a total loss was dreaded, and, in not a few cases, one half of the crop was actually destroyed. The minute symptoms of the blight were these:

* Vol. ii.

1st, In the very early stages of the disease, and Diseases of Plants.
before the ear was affected, the blades and stalks were marked with black and rusty spots. These spots seemed to be occasioned by a glutinous substance deposited upon them, easily soluble in water, and which could be readily washed off by rubbing the stalks with a wet cloth. Some spots, however, were white, and these seemed to be owing to wounds or punctures made by vermin; the leaf having, to a certain extent, in consequence of these, withered and become white. As the season advanced, the black and rusty-coloured spots became larger and more numerous: and when the grain began to ripen, not only the blades but the straw were almost entirely discoloured with black spots.

2d, After the crop had begun to shoot, and was in the ear, many of the heads were entirely empty. Where the stalk was green, and to appearance tolerably healthy, but the ear at the same time withered and without grain, the misfortune seemed to have arisen from an injury done to the neck of the ear, at the place of its junction with the stalk. There the outer rind was destroyed all round, which must have cut off the circulation between the ear and the stalk, as happens in trees that have had their bark destroyed all round.

3d, Many of the ears were entirely empty in the upper part, while the lower half was well filled. In these cases, the injury seemed owing to the rind being destroyed about the middle of the ear, at that place which separated the full from the empty part, and was similar to the injury done in the preceding case where the whole ear was destroyed.

4th,

Diseases of Plants. 4th, In very many cases the ears had a plump well-filled pickle and an empty husk alternately. In these the injury seemed owing to a wound inflicted at the bottom of the empty grains, where they are joined to the stalk, and which had taken place while they were in flower, preventing them from making any farther progress.

5th, Many ears, though not entirely empty, contained only small shrivelled grains, or what are called *hungry pickles*. These seemed to have escaped any accident till they had made some progress in filling, after which they became stationary and ripened prematurely. On examination they were found to be injured at the place where they were joined to the stalk, in the same manner as was already mentioned, in the case of those that had empty heads or ears. Like these also the whole ear was in some cases ill-filled. In others only half of it was in that state, and in a very great number the ears consisted of a well and ill-filled grain alternately. Without a single exception, the whole of the ill-filled or hungry grains, were wounded at the place of their insertion into the ear.

6th, A number of ears, though well-filled, were, upon opening the husks, found almost entirely covered with black and rusty spots, nearly resembling those already described, and like them also they were easily rubbed or washed off. The downy part of many of these grains, when examined carefully with a good glass, appeared to contain several small white transparent globules, resembling the eggs of insects.

7th, In many fields, especially such as had been fallowed and well manured for the wheat crop, a great number of plants were entirely withered from top to bottom,

bottom. The decay, in most of these cases, took place Diseases of when the wheat was beginning to shoot. No injury Plants. was visible in these cases upon the blade or stalk, but on examining the roots, a worm was found at every one of them.

Lastly, As the crop began to whiten, the dark or rusty spots on the straw and ears became more numerous, and appeared more conspicuous. In place of putting on a white or yellow appearance, the whole crop looked as if it had been sprinkled with soot.

The whole of these symptoms appeared to arise from the attack of an insect, and from the injuries and depredation which it committed upon the plants. This insect, when first distinguishable by the eye, was of a red colour, and so soft as to be killed by the slightest pressure. As it increased in size the colour gradually changed to a dirty black, at which it became stationary. During its growth it lost its soft texture, and in proportion as its colour darkened it became hard, and as it were covered with a crust or shell upon the back. It is said to be not uncommon, and to be met with at all times, even in the best fields of wheat, though its numbers are infinitely increased in late wet seasons. From its eggs appearing to lodge upon the well-filled ears of the grain, it might be considered as in danger of being propagated to the succeeding crop. On this account our author hazards some conjectures upon the best means of preventing future danger from it. One of these consists of the use of lime mixed up with all manure, with a view to prevent insects from being generated in it. It is also suggested that the manure, by means of which slugs and worms are chiefly supposed to be produced, ought not to be ploughed into the ground

Diseases of ground in autumn, but applied as a top dressing in
Plants. the spring; because it is understood that manure,
exposed to the sun and air, has much less tendency
to foster insects, than when it is covered up in the
earth.

Mildew
is red or
black, call-
~~ed smut.~~

Another disease, which is much more destructive to wheat, and much more frequently met with, is the mildew. It is of two kinds, the black and the red. In both cases it consists of a quantity of seemingly coarse powder attached to the grain in the ear, or loosely surrounding it; in consequence of which it is evidently prevented from filling or arriving at perfection. The black kind of mildew is by far the most frequent and the most pernicious. It is most generally known in England by the name of *smut*, and in Scotland, by that of the *black*, both of which are sufficiently expressive. Concerning the cause of this disease various opinions have been entertained. Dr Home, in his Principles of Agriculture and Vegetation, ascribes it to an over luxuriancy of growth. He is of opinion, that too great an abundance of juices in a vegetable will produce diseases similar to those occasioned by repletion in animal bodies, viz. stagnations, corruptions, varices, caries, &c. along with the too great luxuriancy we have just now mentioned, which he expresses by "too great an abundance of water shoots." Hence he is induced to class the smut among diseases arising from this cause, it being a corruption happening most in rainy seasons and to weak grain. Like other contagious diseases, he tells us, the smut may be communicated from the infected to healthful grain. As a preventive he recommends steeping the seed in a strong pickle of sea salt. Besides the effect which this has upon the grain itself,

it

it is useful for separating the good from the bad; the best seed falling to the bottom, and the faulty swimming on the top of the liquor. Diseases of Plants.

Independent of this notion of an over luxuriancy of growth, it may be observed, that two opinions have chiefly been supported by persons who have speculated and written on this subject. One opinion is, that the mildew consists of a great multitude of parasitical plants adhering to the grains of wheat, living upon it, and thereby consuming its substance. Another opinion is, that it consists of great numbers of insects and of eggs of insects, whose form is too small to be distinguishable by the naked eye. The first of these opinions has been adopted by the celebrated Italian writer Fontana, and the other by certain writers of our own country.

Fontana endeavours to refute the hypothesis, that the dust of the mildew consists of animal eggs, by the following experiment. He closely confined the grains of the mildew between two glass plates, in such a manner as necessarily to break the supposed eggs. He then, with an accurate microscope, observed them while crushed in succession. No liquid or glutinous juice proceeded from them, though great force was used in crushing them; but they appeared wholly to consist of tough resisting substances, altogether unlike real animal eggs: their being fastened to the stalk or leaves of the grain, appeared also to militate against such a supposition. From a variety of microscopic observations, he is of opinion, that the powder of the black mildew or smut consists of a great multitude of small plants attached to the grain by a slender fibre. These parasitical plants, though extremely small, he thinks sufficiently

Diseases of sufficiently regular. With regard to the red mildew ^{Plants} he admits, that it appears to be composed of an immense multitude of minute eggs. After a variety of experiments and observations, however, he thought he discovered, that these apparent eggs are in truth the heads or fruit of very fine threads fixed on the ear of corn; that these threads or stems are exceedingly fine and transparent, which gives the appearance of eggs to their outward extremities. These stems or tails are represented by him, as infinitely finer than those of the black mildew; and their heads, which resemble eggs, may be separated from them by the slightest shock. From all his observations he concludes, that both the black and the red mildew consist of real plants, though, perhaps, of an imperfect kind; and that they enfeeble and waste the crop by absorbing the nutritive juices of the plant. He observes, that, if a heavy rain speedily fall on an extensive mildew, washing the leaves and stalks affected, it presently disappears with hardly any damage to the corn; because the small plants having hardly taken root are easily dispersed before any mischief is done. He thinks, that the damage occasioned by this disease may sometimes be moderated or diminished by cutting down the grain before it is fully ripe. In this case, he says, that the crop will be less than it ought to be; but still it will be considerably greater than if the customary time of harvest is waited for, when the disease will have leisure to produce greater mischief.

In our own country, and particularly by Mr Somerville, in the essay already quoted, the smut in wheat has been regarded as consisting of a great variety of insects. He also founds his opinion upon microscopic

observations, and apprehends that from them he has Diseases of Plants. clearly ascertained the existence of the insects; and he thinks that the disease is communicated to other grain by contact, in consequence of the passage of the insects. Hence he endeavours to explain the utility of steeping the seed in pickles before it is sown, with a view to the destruction of such insects.

It is to be remarked, that in all countries a great variety of these pickles has been contrived, with a view to prevent the existence of smut in wheat, some of mildew, which we shall now mention. One of the most common is the salt pickle, consisting of a solution of common salt in water, of such strength as that an egg will swim in it. To the wheat, after it has been washed in this pickle, and the light grains removed, some new flaked lime is added, and carefully mixed with it with a wooden shovel, till it attain a sufficient degree of dryness, in which state it is committed to the earth. A pickle consisting of very stale urine has also been recommended to be used for washing wheat that is meant to be used as feed. It is attended with this disadvantage, however, that if the urine is very stale, and if any length of time is suffered to elapse, in consequence of rain or other accidents, before the grain is sown, its vegetative power is said to be greatly injured by the corrosive quality of the volatile alkali with which such urine abounds. This is more particularly the case when quicklime is added to the urine; as the alkali is then brought into a caustic state.

Another pickle has been proposed to the Board of Agriculture by the Italian physician, J. B. Scandella. It is prepared and used in the following manner: —Take of nitre, three pounds; alum, one pound; vi-

VOL. I. L triol,

Diseases of triol, six ounces; verdigris, three ounces; wood-ashes, Plants. well sifted, six pounds: Boil the whole in a copper with five pails of water for an hour, then remove them from the fire, and pour them into a large vessel; then add sixteen pails of water, in which half a bushel of quicklime has been previously dissolved: mix the whole intimately, and allow them to stand till they are quite cold. In this steep, two bushels and a half of wheat are to be plunged, and left for about six hours, stirring it up frequently with a wooden shovel, and skimming off what rises to the surface; the wheat is then to be withdrawn, and spread out till it is dry enough for sowing. The process is thus to be continued until the whole quantity of seed intended to be sown is pickled. The above steep is generally sufficient for preparing about twenty-four bushels of wheat.

Another pickle has been recommended, * consisting of a decoction in water of Barbadoes aloes, tobacco, and hellebore powder. A committee of the Royal Society of Agriculture at Paris, in 1786, recommended the following pickle for the same purpose, contrived by M. Tillet †:—Pour upon 50 pounds of wood-ashes, 900 pints of water; stir it well for three days, and then draw off. Wash the black wheat in so many clear waters as not at last to dirty it. Heat the lye, so as just to bear the hand in it; flake in the hot lye one pound of lime to every seven or eight pints of it. Into the preparation dip the seed in baskets many times. For want of wood-ashes use potash, seven or eight pounds for 100 pints of water.

In

* *Communications to the Board of Agriculture*, vol. ii.

† *Annals of Agriculture*, vol. ix.

In addition to these it may be remarked, that a solution of arsenic in water is made use of in some countries of England, as a pickle in which they wash or steep the grain previous to its being sown for the purpose of protecting the future crop against smut. Diseases of Plants.
Arsenic used to prevent the mildew.

The most complete set of experiments, however, Arthur Young, Esq. which we have met with upon the subject, was made his experiments to prevent mildew. by Arthur Young, Esq. at present secretary to the Board of Agriculture. December 7. 1787, he sowed 14 beds with the same seed wheat as black with the smut as any he ever saw.

- Nº 1. Sown dry, nothing done to it.
- 2. Washed well in clean water.
- 3. Washed in lime-water.
- 4. Washed in a lye of wood-ashes.
- 5. Washed in an arsenic and salt mixture.
- 6. Steeped in lime-water four hours.
- 7. Ditto in the lye four hours.
- 8. Ditto in the arsenic 12 hours.
- 9. Ditto in lime-water 12 hours.
- 10. Ditto in the lye 12 hours.
- 11. Ditto in the arsenic 12 hours.
- 12. Ditto in the lime-water 24 hours.
- 13. Ditto in the lye 24 hours.
- 14. Ditto in the arsenic 24 hours.

RESULT.

Nº 1. Had	377 smutty ears.	
2. Ditto	325	
3. Ditto	43	
4. Ditto	31	
5. Ditto	28	
	L 2	6. Ditto

Diseases of Plants.	Nº	6. Ditto	12
	7. Ditto	3	
	8. Ditto	1	
	9. Ditto	6	
	10. Ditto	0	
	11. Ditto	4	
	12. Ditto	0	
	13. Ditto	0	
	14. Ditto	5	

Erskine of
Marr's re-
medy.

A proposal has also been made, to destroy by means of heat the insects which are supposed to propagate the disease called *smut* from the feed wheat to the future crop. The following directions for that purpose are extracted from the Agricultural Survey of the County of Clackmannan, by J. F. Erskine, of Marr, Esq. "Let the wheat be laid upon the kiln about three or four inches thick : the kiln to be heated middling strong with blind coal ; the wheat to continue on the kiln for 24 hours, but turned frequently. After taking it off the kiln, it must be allowed 24 hours to cool ; during which time it must be frequently turned ; then put it through the fanners once or twice. After the wheat has lain a few hours on the kiln, and the fire begins to have effect, a great number of very small worms, formerly undiscovered by the eye, appear on the top of the grain, and are soon destroyed by the heat. These come from blacked wheat, or other corns, that could not be suspected to be indifferent ; or may lie in or on good wheat ; which worms continuing, (when not thus killed) might consume the corn after it is thrown into the earth, thereby checking the growth entirely, or preventing it from having the strength it otherwise would have to bring forth

forth a strong productive stalk. This practice is said to have been brought from Ireland, and is recommended as preferable to pickling. It might perhaps be performed with greater success by the use of a kiln heated by the steam of boiling water, in the way already mentioned, as such a kiln would instantly afford a fixed and known degree of heat, which could in no case be exceeded." Diseases of Plants.

The subject is thus treated by a correspondent of Mr Young †. "The cause of smut-balls is simply this: every grain of wheat, that the *dust* of these smut-balls shall touch and *adhere to*, is thereby caused to produce smut-balls, the next season, as certain as the smallest quantity of matter put into the arm of any person who hath not had the small-pox, causeth such to have that disorder. This dust is of a very virulent nature; and wheat being extremely susceptible, is liable to take the infection various ways.

"I am fully convinced, and believe that most of my readers will soon be so, that wheat is not liable to this disorder, but by contagion, as is the case in the small-pox; and to those who may query from whence smut-balls at first proceeded, I think I may safely promise an answer to their question, on their informing me of the origin of that contagious disorder. For it evidently appears, that where men have, at their first entering into the farming life, had wheat for seed *free from smut-balls, and their barns, &c. all free from infectious matter*, and not being in the practice of unnecessarily changing their seed, (as too many are) they have continued clear, whilst perhaps several of their neighbours have been often pestered

Diseases of pestered with it, although they have frequently changed Plants. their feed, (a part of it every year) at a great expence, giving an advanced price in the purchase, and having it brought from a considerable distance.

“ When I first supposed that the cause of smut-balls was owing to their dust adhering to the grains of wheat, I took four gallons of wheat which abounded with them, and rubbed all well together with my hands, by which most of the balls were broken, and the grains of wheat tinged with the dust; in this state it was sown. And believing that something of a *cleansing nature* was all that is necessary to remove the cause; I took two bushels of the same parcel of wheat, which, after being well winnowed, was taken to a brook and washed in the following manner: viz. A gallon at a time was put into a wire sieve, which had eight bars to an inch; at first it was gently immerged a few times in the water, by which every smut-ball amongst it was easily discovered and taken away; this being done, the sieve was whirled round briskly in the water for about a minute; then all being washed in the sieve, and thrown into a tub with some water, was stirred round with a broom, and lastly, put into the sieve again, a gallon at a time, and washed in the brook, expecting that the remaining particles would sink through the bottom of the sieve, and be carried away with the stream.

“ This was sown in the same field with the former, where no different kind of manure could have the least tendency to produce smut-balls, amongst either this or that. But at harvest the difference in the crops astonished every one who saw them: the first produced as many smut-balls as grains of wheat, but the latter was almost perfectly free from them.

“ The

“ The next year, I took some grains of wheat which had been *rubbed out* of ears that contained both wheat and smut-balls, and sowed half of them in that smutted state ; the remainder was well washed in water, and then sown near the unwashed grains in a separate drill : at harvest the produce of the two was opposite ; the first yielded exactly twenty-four ears of smut-balls to one ear of wheat, the other about twenty-four of wheat to one ear of smut-balls.

“ The same season, two bushels of the under part of the heap, and the sweepings, were washed and sown like those already mentioned ; the produce was very similar, both being nearly free from smut-balls.”

The same writer adds, that from experiment he is satisfied, that the most smutty wheat may at once be cleaned in such a manner, that it will produce grain of a perfectly sound quality. This however, he says, cannot be completely accomplished by washing with cold water, on account of the defective nature of its cleaning powers. He recommends therefore a wash to be made of boiling water and new burned lime, to be used at a moderate warmth. He describes the process thus : “ I recommend those who buy wheat for feed, or are about to sow such as they are suspicious of, to wash it in the manner I have already described ; but if washing in a brook is not convenient, wash it as well as circumstances will admit, having an eye to the end intended to be obtained, viz. to dispossess the wheat from all infectious matter. Afterwards put it into a tub or cistern, and pour so much thin wash, such as plasterers make use of to white-wash walls, &c. made of boiling water, and new *burnt lime*, as will cover the wheat wholly for the space of six, eight, or twelve hours ; then pour it

Diseases of ^{Plants.} forth on a sloping floor, and in a few hours it will be dry enough to sow.

" But observe the necessary care of not making use of this wash in so hot a state as to injure vegetation ; about the medium between boiling and milk or blood warm will be a proper degree, as the wheat will reduce its heat instantly."

After all, however, both from the reason of the thing, and from the concurring opinion of the most experienced and intelligent farmers, we think ourselves authorized to say, that the husbandman will act imprudently if he place entire and complete confidence in any one of the remedies above mentioned, to the exclusion of the others. His safest and best plan for procuring crops of wheat free from smut is probably this : In the first place, he ought to procure seed from a situation in which the grain has risen absolutely free from this disease. He ought next to exert the greatest care in cleaning out, in the most anxious manner, his whole barns and their floors, and every place within doors into which his grain may come, and in which diseased grain has formerly been kept : with this view it may probably be necessary to whitewash the walls with a mixture of quicklime and water, which will prove an effectual remedy. After having adopted these precautions, it may still be necessary, with a view to secure a sound and full crop, to plunge the seed into a strong pickle of salt and water, with a view to float the lighter grains, which ought to be skimmed off and laid aside for poultry, to which they may be given after being washed in fresh water ; or at least it may be proper to use the precaution of washing the seed in a running stream, or in warm

warm lime water. No future change of seed will be necessary. Of the farmers who have adopted this judicious mode of proceeding, there is no instance recorded of any one whose crop has suffered by smut; on the contrary, they have usually derived a considerable profit from becoming the furnishers of grain for seed to all their neighbours.

The want of nourishment in plants may be easily known by their decay; in which case, the only remedy is, to supply them with food, according to the methods we have already directed, or to remove from their neighbourhood such other plants as may draw off the nourishment from those we wish to cultivate.—In the Diseases peculiar to saffron. Memoirs of the Academy of Sciences for 1728, Mr Du Hamel mentions a disease, which he calls *le mort*, that attacks saffron in the spring. It is owing to another plant, a species of trefoil, fixing some violet-coloured threads, which are its roots, to the roots of the saffron, and sucking out its juice. This disease is prevented by digging a trench, which saves all the unaffected.

The bad qualities, and unequal distribution of the Vegetables destroyed by insects. juices of plants, are the occasion of so few of the diseases to which vegetables in this country are subject, that we forbear to mention them at present. Most of the diseases of our plants are owing to external accidents, particularly to the depredations of insects.—The insects by which the greatest devastations are committed in this country are, snails, caterpillars, grubs, and flies. The snails and caterpillars feed on the leaves and young shoots; by which means they often totally destroy the vegetable. Where the plants are of easy Insects destroyed by lime-water. access, these vermin may be destroyed by sprinkling the vegetable with lime-water; for quicklime is a mortal

Diseases of tal poison to creatures of this kind, and throws them
^{Plants.} into the greatest agonies the moment they are touched with it. On trees, however, where this method cannot so well be followed, fumigation is the most proper; and, for this purpose, nothing is better than the smoke of vegetables not perfectly dry. In some cases the eggs of these destroying creatures may be observed, and ought without doubt immediately to be taken away. On the fruit trees, as apples, pears, medlars, on some forest trees, the oak and dwarf maple especially, and the white and black thorn in hedges, a kind of little tufts are to be observed, resembling at first sight withered leaves twisted by a cobweb about the uppermost twigs or branches. These contain a vast number of little black eggs, that, in the spring, produce swarms of caterpillars which devour every thing. To prevent this, all the twigs on which these cobwebs appear should be taken off and burnt as soon as possible. This ought to be done before the end of March, that none of the eggs be allowed sufficient time for hatching.

Grubs

Grubs are a kind of worms which destroy the corn by feeding upon its roots; they are transformed every fourth year into the beetles called *cock-chaffers* *may-bugs*, &c. they are very destructive when in their vermicular state, and cannot then be destroyed because they go deep into the ground. When become beetles, they conceal themselves under the leaves of trees, where they sleep till near sunset, when they take their flight. It is only now that they can be destroyed, and that by a very laborious method; namely, by spreading pack-lice below the trees in the daytime when the beetles are in their torpid state, then shaking

shaking them off and burning them. Some time ago Diseases of Plants.
they made such devastations in the county of Norfolk, that several farmers were entirely ruined by them ; one gathered 80 bushels of these insects from the trees which grew on his farm. It is said, that in 1574 there fell such a multitude of these insects into the river Severn, that they stopped and clogged the wheels of the water-mills.

Turnips, when young, are apt to be totally destroyed by a multitude of little black flies, from thence called the *turnip-fly*. As a preventive of these, some advise the seed to be mixed with brimstone ; but this is improper, as brimstone is found to be poisonous to vegetables. The best method seems to be the fumigation of the fields with smoke of half-dried vegetables. For this purpose weeds will answer as well as any. This fumigation must no doubt be often repeated, in order to drive away the innumerable multitudes of these insects which are capable of destroying a large field of turnips.

Some have supposed that the fly is either engendered in new dung, or enticed by it ; and have therefore advised the manure to be laid on in the autumn preceding, by which it loses all its noxious qualities, while its nutritive ones are retained, notwithstanding these might be supposed liable in some degree to be exhaled by the sun. This method is said to have been ascertained by experiments ; and it is added, that another material advantage accruing from autumn manuring for turnips is, that all the seeds contained in the dung, and which of course are carried on the land with it, vegetate almost immediately, are mostly killed by the severity

Diseases of verity of the winter, and the few that remain seldom Plants. avoid destruction from the ploughshare.

Various re-medicis a-against the turnip-fly. The following method of sowing has also been recommended as a preventive of the fly :—“ About mid-summer, take the first opportunity when it rains, or there is an apparent certainty of rain approaching, to sow your turnip seed ; if about the full moon, the better. In this case, neither harrow, brush, nor roll, after sowing. The natural heat of the ground at that season, and the consequent fermentation occasioned by copious rain, will give an astonishingly quick vegeta-tion to the seed, which in a few days will be up and out of all danger from the fly. At all events, sow not till it rains ; it is better to wait a month, or even longer, for rain, than to sow (merely for the sake of sowing about the usual time) when the ground is parched with heat. By the scorching of the sun, the oil and vegetative quality of the seed are exhausted ; and the few weak plants that come up will be destroyed by the fly before they can attain strength to put forth their rough leaves. The fly infests the ground abundantly in dry hot weather, but does no injury in rain. The falling rain will sufficiently wash the turnip seed into the ground without harrowing it in : which, instead of merely cover-ing, too often buries this small seed at so great a depth, as never afterwards to get above ground.”

The following remedies are also recommended as having often proved successful :—A small quantity of foot town over the land at their first appearance. Branches of elder, with the leaves bruised, drawn in a gate over them. Muck mixed with the seed before it is sown. And sulphur burnt under it, after moistening it with water in which radish has been steeped.

But showers on the plants, as soon as they appear above ground, are esteemed the best preservatives. Diseases of Plants. They enfeeble and kill the fly, and hasten the plants into the rough leaf, in which state they are out of danger.

The sweet smell of the turnip has been thought to attract the fly; upon which supposition, the remedy appeared to consist in overpowering that smell by one which is strong, fetid, and disagreeable. Hence it has been recommended, that upon an acre of turnips sown in the usual way, a peck or more of dry root be thrown after the ground is finished, and in as regular a way as the seed is sown.

It has also been recommended to sow about two pounds of radish seed on every English acre sown with turnips. The radishes rise before the turnips, and entertain the fly till the turnips are out of danger. The radish and turnip seeds ought to be sown at the same time, and may be mixed by the seedsmen or person employed to sow.

Some time ago an insect, called the *corn-butterfly*, committed such ravages while in its vermicular state, in France, that upwards of 200 parishes were ruined by it; and the ministry offered a reward to the discoverer of an effectual remedy against this destroying worm. The cure which was at last discovered was, to heat the corn in an oven so much as not to destroy its vegetative power, but sufficiently to destroy the small worms which made their nest in the substance of the grain, and at last ate out the substance so completely, that nothing could be got from the husk even by boiling it in water. It is certain, that though insects can bear a great deal of cold, they are easily destroyed

Diseases of destroyed by a slight degree of heat; nor is the vegetative power of corn easily destroyed, even when kept for a long time in a pretty strong heat. This method must therefore be very effectual for destroying all kinds of insects with which grain is apt to be infected: but care must be taken not to apply too great a heat; and the adjusting of the precise degree necessary to destroy the insect, without hurting the corn, will be attended with some difficulty. The precautions recommended when treating of the mildew in wheat, may be adopted with success.

The curled disease in potatoes.

The curled disease in potatoes has long been a subject of investigation and experiment among farmers: and the knowledge of its cause and cure seems yet to remain a desideratum. The Agricultural Society at Manchester, a few years ago, offered a premium for discovering by actual experiment the cause of the disease in question; and a great variety of letters were, in consequence, addressed to them upon the subject.— As these contain many interesting observations both on the disease itself and the best methods hitherto adopted for preventing it, the following abstract of them may not improperly be introduced in this place.

Various methods of prevention.

I. According to the writer of the first letter, this disease is caused by an insect produced by frost or bad keeping before setting; and the newest kinds, such as have been raised within these nine or ten years, are most apt to curl, because they will not stand to be kept in winter and spring before setting, as the old kinds will. In autumn 1776, he got up a bed of potatoes to lay by in winter, leaving plenty in the ground as regular as possible; and, before the severity of winter came on, covered part of the bed with straw and pease-haulm, and left the other part of the bed uncovered.

That part of the bed which was covered was quite free from curled ones; but the uncovered part produced a great many curled; owing, as the writer says, to frost and severity of the weather..

II. This writer had about a quarter of an acre of potatoes, well manured with cow and horse dung, and took the greatest care in picking the fine smooth-skinned potatoes for sets; yet nine out of ten parts were curled. He attributes the cause of this disease to a white grub or insect, which he found near the root, about half an inch long, with eight or ten legs, its head brown and hard; as, upon examining a number of the curled roots, he found them all bitten, chiefly from the surface to the root, which of course stopped the progress of the sap, and threw the leaf into a curl. The uncurled roots were not bitten. He tried a few experiments as follow: First, he put foot to the insects in the rows for two days; and after that, he put lime to them for the same time, but they still kept lively: next he put a little salt, which destroyed them in a few hours. From which he infers, that if coarse salt were put into the ground at the time the land is preparing for potatoes, it would effectually cure this distemper.

III. In this letter, the cause of the disease is attributed to the method of earthing the stems while in cultivation; and the branch, striking root into the new earthed-up soil, it is said, produces potatoes of such a nature as the year following to cause the disease complained of.

To prevent the disease, it is recommended to take the sets from those potatoes that have not bred any from the branch covered; or, otherwise, to dig the part the sets are to be raised from.

IV.

Diseases of Plants. IV. According to this writer, the disorder proceeds from potatoes growing in old-tilled or worn-out ground; for though these potatoes may look tolerably well, yet their sets will mostly, if not all, produce curled potatoes.

Hence he is convinced, that no sets ought to be used from old-tilled or couch-grafts land; and that, in order to have good sets, they should be procured from land that was purposely fallowed for them; from fresh ley land, where they are not curled; or from ley land that was burnt last spring.

To avoid the uncertainty of getting good sets, he recommends crabs to be gathered from potatoes growing this year on fresh land free from curl, and the next spring to sow them on fresh ley land; and continue to plant their sets on fresh ley land yearly, which he is convinced will prevent the curl.

V. In 1772, this writer planted some potatoes by accident full nine inches deep: when taken up, many of the plants were rotted, and a few curled. He kept the whole produce for seed, and planted two acres with it in 1773, not quite six inches deep. The crop was amazingly great; and he did not observe any curled plants among them. In 1774, many of these were planted in different soils; yet they were so infected with the curled disease, that not one in twenty escaped! In 1775, the complaint of this disease became general. In 1776, it occurred to him that the good crop of 1773 was owing to the accidental deep setting of 1772; and that the reason why the same seed became curled in 1774, was their being set so near the surface in 1773; and attributes the disease to the practice of ebbing. In 1777, he took some potatoes from a crop that was curled the year before, and after cutting the

sets, left them in a dry room for a month. Half were planted in ground dug fourteen days before ; the other half, having been steeped in a brine made of whitster's ashes for two hours, were also planted in the same land at the same time. The steeped ones came up ten days before the others, and hardly any missed or were curled. The unsteeped ones generally failed, and those few that came up were mostly curled.

He therefore advised as a remedy, 1. That the potatoes intended for next year's sets be planted nine inches deep. 2. That they remain in the ground as long as the season will permit. 3. That these sets be well defended from frost till the beginning of March. 4. That the sets be cut a fortnight before planting. 5. That they be steeped, as above, two hours in brine or lye. 6. That the dung be put over the sets. And, 7. That fresh sets be got every year from sandy soils near the coast, or on the shore.

P. S. At planting, the hard dry sets should be cast aside, for they will probably be curled. Curled potatoes always proceed from sets which do not rot or putrefy in the ground.

VI. This writer had five drills of the old red potatoes, and four of the winter whites, growing at the same time in the same field. The drills were prepared exactly alike. Among the red not one was curled ; the winter whites were nearly all curled. He says he has found by experience, that the red never curl.

VII. Two of the writer's neighbours had their sets out of one heap of potatoes. They both set with the plough, the one early, and the other late, in the season. Most of those early set proved curled, and most of those set late smooth ; the latter on clay land.

Diseases of
Plants. A few rods of land were also planted with small potatoes, which had lain spread on a chamber floor all the winter and spring till the middle of May. They were soft and withered ; they proved smooth and a good crop. Middle-sized potatoes, withered and soft, which had been kept in a large dry cellar, and the sprouts of which had been broken off three times, produced also a smooth good crop.

Hence he was led to think a superfluity of sap, occasioned by the seed being unripe, might cause the disease.

He concludes, the only sure way to prevent the curl is, to let potatoes intended for seed stand till they are fully ripe, and to keep them dry all winter.

VIII. This writer set a quantity of the red potatoes, without having a curled one amongst them. His method is, when the sets are cut, to pick out such as are reddest in the inside. On digging them up at Michaelmas, he mixes none of the curled seed among the others. The curled are easily distinguished, by their stalks withering two months before the rest of the crop.

The cause of the curled disease he attributes to potatoes being of late years produced from seed instead of roots, as formerly. Such will not stand good more than two or three years, use what method you please. Last spring, he set the old red and white rufflets, and had not a curled potato amongst them.

On the limestone land about Denbigh, in North Wales, they have no curled potatoes. If this be owing to the nature of that land, perhaps lime might prevent the disease.

IX. According to this writer, all sorts of grain wear out and turn wild if sown too long on the same land ;

land; the same will hold good in all sorts of pulse, Diseases of Plants. peas, beans, and (as he conceives) potatoes. It generally happens, that those who have most curled potatoes plant very small sets.

Eleven years ago he bought a parcel of fresh sets, of the golden-dun kind, and has used them without change to the present year, without any being curled. This he principally attributes to his having always planted good large sets.

About four years since, he thought of changing his sets, as his potatoes were too smooth, too round, and much diminished in size. But the curl at that time beginning to be very alarming, he continued his sets till part of his crop missing last year, he was obliged to buy new sets this spring, which, being small, were curled like other people's.

He allows, that the curl has frequently happened to persons who have used large potatoes for sets; for, as all roots are not equally affected, some curled ones may be mixed with the rest.

To prevent the evil, cut your sets from clear and middle-sized potatoes, gathered from places as clear of the curl as possible; preserve them as usual till spring. If any are harder, or graft more in cutting than usual, cast them aside. He would also recommend the raising a fresh sort from the crab produced on the sorts least affected, which in Lancashire are the long-duns.

X. Set potatoes with the sprouts broke off, and they will (says the writer of this letter) be curled ones; if set with the sprouts on, they will not be curled. Again, take a potato which is sprout, and cut a set off with two sprouts: break one sprout off, and let the other stay on,

Diseases of and set it; the former will be curled, and the latter Plants. will not.

When you have holed your potatoes, take them out before they are sprit, and lay them dry until you have set or sown them, and you will have no curled potatoes.

XI. This writer was at the expence of procuring sets at fifty miles distance, and where this disease was not known. The first year's trial was successful; the year following he procured sets from the same place, but one-fifth of his crop was infected. By way of experiment, he planted sets from roots which had been infected the year before, and some of these produced healthy plants, free from all infection.

As every effect must have a cause, he supposed it might be some insect, which, living on the leaves, gave them that curled and sickly appearance, as is the case in the leaves of many shrubs and trees. But whether the insect is lodged in the old sets, and to be destroyed at the time of planting, or, proceeding from some external cause, can only be destroyed afterwards, he is not yet certain, although he has made the following experiments.

On a piece of ground that had not been dug for 20 years, he planted four rows of sets, which he knew to be perfectly clear; the drills were two feet distant, the sets one foot distant in each drill. He then planted on the same ground four rows with sets from curled potatoes, at equal distances; in each row were about 20 sets.

Lot 1st, The curled sets.

N ^o 1. Without manure,		N ^o 3. In foot,
2. In salt,		4. In quicklime.

Lot

Lot 2d, The clear sets.

N ^o 1. Without manure,	N ^o 3. In foot,
2. In salt,	4. In quicklime.

Those planted in salt and foot in both lots were destroyed. In Lot 1st, N^o 1. and 4. all curled. Lot 2d, N^o 1. and 4. quite clear.

This experiment was made on a supposition that the insect lodged in the set, and must be destroyed on planting. But of that he is not fully satisfied. He repeated salt, foot, and quicklime, on the branches of several curled potatoes. Salt destroyed all he touched with it. Lime and foot had, he thought, a partial effect on the plants. After some time, they appeared almost as healthy as the rest. Thus, although he had done little towards the cure, he flatters himself he has pointed out the cause, the insects on the curled plants being not only very numerous, but visible to the naked eye.

XII. This writer ascribes the cause of the disease to the frost, and bad keeping in winter and spring before setting. They are liable to be damaged by frost after they are set; but this may be prevented by covering. If it be asked, why frost did not injure them formerly? he answers, it is only the new kinds which are apt to curl. To this may be added, that less care is now taken of the seed than formerly. To prevent the latter, let them remain in the ground covered with haulm or litter till the time they are wanted for setting: and, in case no frost touches them afterwards, they will be free from the disease.

XIII. This writer says, the red potato was as generally planted as the winter white and the Lincolnshire

Diseases of kidney are now. The first, being a later potato, did
Plants. not sprout so early as the others. The white sprout very early, and therefore should first be moved out of the place where they have been preserved in the winter. Instead of that, they are often let remain till their roots and sprouts are matted together. On separating them, these sprouts are generally rubbed off, and they are laid by till the ground is ready; during which interval they sprout a second time: but these second sprouts, being weak and languid, will shrink, ficken, and die; and the fruit at the roots will be small, hard, ill-shaped, and of a brown colour.

Now, if putting off the sprouts once or more, before the sets are put in the ground, be the cause (as he verily believes it is) of the curled disease, an easy remedy is at hand. When the potatoes intended for sets are dug up, lay them in a west aspect as dry as possible: in such a situation they will not sprout so soon. The best time for removing most sorts, is the first fine day after the 24th of February. Cut them into sets as soon as possible, and let them remain covered with dry sand till the ground is prepared, which should be a winter fallow. Lay the sets in without breaking off any of the sprouts, for the second will not be so vigorous. This accounts for one sprout out of three from the same set being curled. The two stems not curled rose from two later eyes, and were first sprouts. The sprout curled was a second, the first having been rubbed off.

XIV. This writer says, that last spring one of his neighbours cut and set, in the usual way of drilling, some loads of the largest potatoes he could procure; and more than half of them proved curled. Being a few

few sets short of the quantity wanted, he planted some *Diseases of Plants.* very small potatoes which he had laid by for the pigs. These being fully ripe and solid, there was not a curled plant among them. He apprehends, the others being curled was owing to their not being fully ripe.

XV. Of late years, this writer says, great improvements have been made in setting potatoes and cutting the sets. The ground is dressed cleaner and dunged stronger. Many people, in drilling, wrap up the sets entirely in the dung; by which means, though their potatoes are larger, the disease seems to be increased. They also cut their sets out of the richest and largest potatoes, which is perhaps another cause of this evil. In cold countries, where they set their own seed, which has grown on poor land, with less dung, they have no curled plants. On the contrary, when they bought rich and large potatoes for seed, they have been curled in great quantities. He believes, the richness and largeness of the seed to be the cause of the evil; for he does not remember to have seen a curled stem which did not spring from a set of a large potato.

XVI. This writer apprehends the curled disease in potatoes to proceed from a defect in the *planta seminalis*, or seed plant; and from comparing curled ones with others, there appeared to be a want of, or inability in, the powers of expanding or unfolding the parts of the former; which, from this defect, forms shrivelled, starved, curled stems. On examining some of the sets at the time of getting the crop, he found them hard and undecayed; so hard, indeed, that some of them would not be soft with long boiling. This led him to think, that some manures might have the same

Diseases of same effect on them as tanners ooze has on leather,
Plants. and so harden them, that the embryo plant could not come forth with ease; but a closer examination taught him otherwise, and that they grow equally in all manures.

He thinks the most consistent and rational opinion is, that the disease is occasioned by the potatoes being taken from the ground before the stamen, or miniature plant, is properly matured and ripened,

One of his neighbours, last year, set two rows of potatoes, which proving all curled, he did not take them up; and this year there is not a curled one among them. Such potatoes, therefore, as are designed for seed, should be preserved as long in the ground as possible.

XVII. This writer advises such sets to be planted as grow in moss land; and, he says, there will not be a single curled one the first year. This is affirmed by the inhabitants of two townships, where they grow amazing quantities. A medical gentleman sowed last year two bushels of sets from one of the above places, and had not one curled; but on sowing them again this year, he had a few.

Notwithstanding there seems to be a diversity of opinions in the above writers, occasioned by the different appearances of their crops, and the seemingly contrary effects of the means used to prevent or cure the disease, we conceive that the following general propositions may be fairly drawn from the whole. 1. That some kinds of potatoes are (*ceteris paribus*) much more liable to be affected by the disease than the rest; and that what are called in England the old-red, the golden-dun, and the long-dun, are the most free from it.—2. That the disease

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is occasioned by one or more of the following causes, Diseases & either singly or combined: 1st. By insects: 2d, By frost, Plants. either before or after the sets are planted: 3d, From planting sets out of large unripe potatoes: 4th, From planting too near the surface, and in old worn out-ground: 5th; From the first shoots of the sets being broken off before planting; by which means there is an incapacity in the *planta seminalis* to send forth others sufficiently vigorous to expand so fully as they ought.—3. That the most successful methods of preventing the disease, are cutting the sets from smooth middle-sized potatoes, that were fully ripe, and had been kept dry after they were taken out of the ground; and without rubbing off their first shoots, planting them pretty deep in fresh earth with a mixture of quicklime, or on limestone or moss land.

A correspondent of the Bath Society is convinced, that, whatever may be its cause, the fault itself is inherent in the seed; and has communicated the following method of avoiding it: “ I made a hot-bed in the following manner (which method I have used ever since): I laid horse dung, &c. (as is generally used in making hot-beds), about 18 inches thick; over which I spread a layer of fine rich mould about four or five inches thick: upon the top of this mould I laid, in different divisions, a certain number of potatoes of various sorts, some of my own growth, and others bought from different parts, and covered these lightly over with more mould; they soon came up. I then observed which was free from the blight or curl; for if there were not more than one defective in forty or fifty, I concluded I might set of that sort with safety. This method I have now practised near twelve years, and never lost my crop, or any part thereof worth mentioning; whilst my neighbours, who followed

Diseases of followed the old method, were frequently disappointed
~~Plants.~~ in their crops; and to the best of my knowledge, all those of my neighbours who have of late been persuaded to take the trouble of using the same means as myself, have never failed of success to their utmost wishes in one instance; nor do I ever think it will fail, if duly attended to. The fault being some hidden cause in the seed unknown at present, and I believe incurable by any means, at least which have yet come to my knowledge; my reason for planting my hot-beds so soon is, that if the frost hinder the first experiment, or they all prove bad, I may have time to make a second or third, if necessary, with different sorts of seed, before the proper season arrives for planting in the fields and grounds appointed for the great and general crops."

In addition to the information upon this subject, which has been obtained by means of these societies, various other speculations about the cause and cure of this disease have of late been introduced to the notice of the public *. In particular it has been strongly urged, that the disease is almost always occasioned by insects. It is said, that on looking at the roots of such potatoes as grow up curled, it will usually be found, that the bearing plant is devoured and excavated by snails, centipedes, or beetles. Sometimes also, though more rarely, the curl is supposed to arise from the leaves themselves being infected with minute animalcula. Hence, in rich soils in the neighbourhood of cities, and well manured gardens, the potatoes are most subject to the curl, because such insects as devour the seed abound most in these

* *Farmer's Magazine.*

these soils. The insects are thought to prefer one potato to another. They will hardly touch a yam. A potato from a late part of the country, which has been hardly ripened, the vermin do not seem to like; but a potato that has been somewhat sweetened or mellowed by the frost, is supposed to be greedily devoured by them.

An ingenious notion concerning the cause of the disease has been suggested from attending to the history of the plant in this country. The potato plant was introduced into the island of Great Britain from a climate much warmer than ours, as early as the reign of Queen Elizabeth; but it is a singular circumstance, that the curled disease did make its appearance till within less than 40 years ago. Indeed *, the disease is said to have first occurred in the year 1764, in the very district of Lancashire where potatoes had been first cultivated. It is also said, that the Surinam potato, and some other kinds which have been more recently introduced into our climate, have never yet exhibited any symptom of the curl. It is farther said, that till within these 40 years the potato plant never brought its seeds to maturity in this country, though the roots were in full perfection; that the Surinam potato and others lately introduced do not as yet produce perfect seeds at the top of their stem; and that potatoes, which have been cultivated for a length of time in bleak and mountainous situations, are still in the same state, and do not bring their seeds to maturity. Hence it is endeavoured to be inferred, that there exists a connexion in the nature of the plant between

* *Transact. Soc. for Encouragement of Arts*, vol. viii.

Diseases of ^{Plants.} between this disease and the state of maturity to which the seed is brought. It is supposed, that the plant is unfit at once to afford mature and perfect seed at the summit of its stem, and also roots capable of propagating it in perfection. From these premises it is suggested, that, to prevent the curl, it will be necessary to procure seed potatoes from mountainous situations into which the disease has not yet come, because the plant has never produced perfect fruit at the summit of its stem ; or an attempt may be made to procure more perfect seed from the ordinary kind of potatoes, by destroying the flowers, which may have the effect to prevent the plant from being exhausted by bringing to maturity both fruit at its summit and roots at its bottom. Lastly, it has been supposed, upon these principles, that the disease may be prevented by rearing potatoes from the seed produced at the summit of the stem ; the mode of practising which will afterwards be explained.

In the mean time, it may be observed, that the subject has been farther discussed, in a less speculative manner, by an anonymous correspondent of the Board of Agriculture *. This gentleman does not consider the curl as a specific disease, but as an accidental debility of those plants in which it occurs ; that we are not, therefore, to seek for a cure or preventive in a change of seed alone, as many have all along done, but in complete attention to all that experience shows to be necessary to an accurate culture, and to their perfect growth. In this way alone, he thinks, there is reason to expect that this very useful article of human food may be cultivated

* *Communications of the Board of Agriculture*, vol. ii.

cultivated with the same success as before its dreadful Diseases of Plants. enemy the curl made such havoc in our crops, as of late years it certainly has done. He describes the disease as occurring, in Mid-Lothian, most frequently from the following causes : 1st, From planting potatoes on soils altogether unfit for them. Being unable to penetrate a stiff soil, potatoes require a light, pervious, or open mould. For a long period after potatoes first appeared in the country, this circumstance was carefully attended to. They were planted entirely with the spade, in the lightest spots upon every farm. Hence, the plants rose vigorous, and no curl was seen ; but on farmers wishing to extend the culture of potatoes, they were tempted to plant them on every soil, without regard to its nature, or tendency to produce this crop. 2dly, Imperfect culture is described as a frequent cause of curling. A crop of potatoes is commonly strong, abundant, and free from curl, in proportion to the previous culture given to the soil, and the care taken to keep it clean after they are planted. Hence, it frequently happens, that while a farmer who cultivates this root in a negligent manner, and upon a great scale, by means of the plough, finds his crop deficient in consequence of this disease ; his cottars and servants, to whose use he allots small portions of potato ground, which they cultivate with the spade, obtain crops free from curl, and often double in quantity to his, in proportion to the extent of ground which they occupy. 3dly, Small roots, or too small a portion cut off along with the eye, that is to serve for seed, appears to be a cause of curl. In the case of grain, it seldom happens, unless in very fine seasons, that small seed produces a large crop ; and it is thought that something similar may occur in the case

Diseases of ~~Plants.~~ case of potatoes. As the young plant must always derive its earliest nourishment from the root, out of which it springs, before it is capable of seeking its food in the surrounding soil, those plants, whose early growth is best supported and fostered, must be expected to reach the greatest perfection. To subject these ideas to the test of experiment, 64 sets were planted; 16 of which were full grown potatoes, 16 from small roots, in which no curl appeared when in the field, 16 from roots raised from the seeds two years before, and 16 from roots of plants strongly curled. They were all planted in the same manner, in a light soil, in parallel furrows, with a moderate quantity of dung, and covered to the depth of three inches. Of those taken from large potatoes, none were curled, and the plants were strong and healthy. Some good plants appeared in each of the other rows, but nearly a half of the whole was curled. The proportion of curled plants was rather greatest in those raised from the seed. 4thly, Sets taken from roots that have sprouted early, and from which the germs have been rubbed, are said never to fail to produce curl. 5thly, Too much, as well as too little dung, appears to have an influence in producing curl; the first probably by corrupting the germ of the young plant, the latter by not being sufficient to produce vigorous plants. Hence, attention ought to be paid to the regular spreading of dung, which ought not to be thrown about in a careless and slovenly manner, which allows some plants to have none, while others are covered with it to the depth of several inches. 6thly, Too deep, as well as too shallow planting, gives rise to the curl. To ascertain the proper depth, 12 were planted at 18 inches deep; the same number at the depth of

16 inches, and of 14, 12, 10, 8, 7, 6, 5, 4, 3, and <sup>Diseases of
Plants.</sup> 2 inches; and 12 were so lightly covered, that they were not, perhaps at the depth of one inch. The sets were all from large roots, of the same crop, cut as nearly as possible of the same size. They were all planted at the same time, in the first week of April, in a light dry soil, and they all got the same quantity of dung. The plants at the depth of 1 and 2 inches appeared first; but they were weak, and some of them curled. Those at 3, 4, and 5 inches, were all strong, and free from curl. At 6 and 7 inches, they were also healthy, and free from curl; but they were three weeks later in getting above the ground than those that were thinly covered, and the plants were neither so strong, nor the roots so large. Those planted at the depth of 8 inches rose still later, and were all weak.—Nine out of the 12 were curled. Of those planted at 10 inches deep, only four appeared; and they were so weak, that they soon withered and died. Of those deeper planted, none ever appeared. On digging them up at the end of two months, those at 16 and 18 inches deep were found unchanged; while some of those at the depth of 12 and 14 inches, had put forth some feeble germs not exceeding the length of an inch. Those planted at 3 and 4 inches were evidently the strongest during the whole season, and their roots largest. Hence to procure an early, abundant, and healthy crop, 3 inches appears to be the best depth for planting potatoes. ^{7thly,} Whatever injures the new sets or the germs afterwards may produce curl: such as the trampling of horses feet at the time of planting; their being partially covered with stones or hard clods of earth; deep harrowing, when the young shoots are advancing; and grubs,

Diseases of grubs, snails, or insects attacking the germs at first, or Plants. the stems afterwards. Hence, 8thly, The curl was produced to an uncommon degree upon a field of stiff land, by passing a roller over it, about a fortnight after planting. 9thly, The state of the weather when the crop is young may produce the curl. Rain alone will not do so, if it be not allowed to lodge; but a long continuance of dry weather, especially with cold winds, when the shoots first appear, is apt to produce this disease, and also hoar-frosts in this early state of the crop. Hence, it is thought, that the three first weeks of April answer best for planting potatoes in the south of Scotland and north of England, as they do not, in that case, appear till the middle or end of May. From all these remarks it is conculed, that, though with the best management, the curl can never be completely banished from our fields, yet with due attention to the leading points above mentioned, it may be prevented from being attended with any serious mischief.

As no information upon this interesting subject ought to be overlooked, we think it necessary to state, that the following plan for preventing the curl in potatoes has very recently been laid before the public, by an anonymous correspondent of the publishers of the Farmer's Magazine, who asserts, that he has adopted with complete success. It consists of using for seed what are called *potato beans*. These beans are a dark brown excrescence, larger than a horse bean, which grows near the ground, on the haulm or shaw, generally, it is supposed, where it has been broken or wounded. They are shaped like potatoes, and have a number of eyes, from one of which grow two small leaves. It is said, that eight or ten years ago, several

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of these potato beans were planted merely to try if they would grow, and that they produced a great number of common sized potatoes, but of a bad quality. These potatoes, however, being cut and planted next year, produced potatoes of an excellent quality, and in great plenty. Since that time, a number of beans have always been planted sufficient to produce enough of potatoes for next year's seed. They are planted at the same distance, and treated in every respect in the same manner with common sets; and their produce is equally plentiful. No other change of seed has ever been necessary.

SECT. VIII.

OF THE OBSTACLES TO AGRICULTURAL IMPROVEMENT.

BEFORE proceeding to the practical part of the subject, it may be proper to take notice of some of the moral and political circumstances which resist the progress of the art of agriculture, and which ought not to be overlooked by persons engaged, or who have an intention to engage in it.

One of the first and most obvious obstacles to the improvement of this or of any other art consists of the ignorance of its practitioners, or of its being carried on by persons of an illiterate and unintelligent character, who are unable to take a comprehensive view of the principles of their profession, or who have not sufficient curiosity to inquire after the best modes of practice, or understanding to discern the value of any new practices.

Obstacles to Agriculture. tices that are explained to them. It ought never to be forgotten, that the art of the husbandman is an intricate and extensive one, and that one of the chief circumstances which has hitherto prevented its improvement has arisen, as already mentioned, from the secluded situation of persons engaged in it. They are scattered over the face of the country, instead of being collected together like other artists in towns, so as to be enabled to derive aid from each other's experience. Fortunately this difficulty is passing away, in consequence of the diffusion of agricultural knowledge, by means of the great number of publications upon that subject which are gradually introducing themselves into the remotest corners of the country. Persons receiving a liberal education, particularly at the university of Edinburgh, have now also an easier opportunity than formerly of acquiring a knowledge of the principles of this art, in consequence of the establishment of a professorship of agriculture, which has been endowed by a private gentleman, Sir William Pulteney. Even with all these advantages, however, aided as they are by the exertions of the Board of Agriculture, it can never be expected that this art can reach its ultimate degree of perfection, unless a considerable number of the persons engaged in it are men of intelligent characters and good education, who will call in the improvements which are making in other sciences as well as in this art, in distant countries, to the assistance of their personal experience.

In speculation, at least, nobody will deny the utility of general knowledge towards success in this profession; as it is evident, that nothing excellent can be accomplished by a very ignorant person in agriculture

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more than in any other art. It has unfortunately happened, however, in some quarters of the country, that the introduction of agricultural improvements has, for some time been delayed, in consequence of the unsuccessful efforts in this department of business of some men otherwise accounted intelligent, who had rashly engaged in husbandry. Men of fortune, when they engage in this or in any other undertaking, are apt to disregard expence when a favourite object is in view, and are unwilling to leave any thing to nature or to time. Hence they introduce costly implements of husbandry, and laborious modes of cultivation, upon a rude, and perhaps upon a poor soil, in a cold and unsheltered situation. Having lavished away much money to little purpose, they become disgusted, and abandon the pursuit of agriculture as unprofitable; and thus their example comes to be regarded by the ignorant as a warning to avoid every kind of novelty; which necessarily puts an end to improvement, because all improvements are new.

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ture

Such occurrences, however, only establish the truth of the maxim, that a little learning is a dangerous thing; a partial knowledge of agriculture leads to hasty schemes, sanguine hopes, and rash undertakings; whereas a correct acquaintance with the nature of a soil, the climate in which it is situated, the market which its neighbourhood affords, and the expence of rearing and bringing thither certain crops, leads to moderate and rational views, and to slow but sure success. This remark naturally introduces the consideration of a point of much importance both to individual husbandmen and to the general improvement of the art; which is, that every person engaging in the profession of a husband-

N 2 man,

Obstacles to Agriculture. man, ought to be well instructed in the best mode of keeping regular accounts of his affairs, and ought never to neglect, any more than a man engaged in commerce, to keep a correct arithmetical record of all his transactions, and of his profits and losses. The want of attention to this point has hitherto been one of the greatest causes of the slow progress of the art of agriculture, and also of the want of success of many individuals in the practice of it. This subject is so well discussed in the Annals of Agriculture *, that, although it is a long quotation, we account ourselves justifiable in inserting it in this place.

"There is not a single step," says this judicious writer, "in the life of a farmer that does not prove the advantage of his keeping regular accounts; and yet there is not one in a thousand that keeps any. This is one, among the many instances, in which the unenlightened situation of the practisers of the art is the evident reason for the backwardness in which the art itself is found by any man who searches for the principles deduced from practice, which ought to give it the regularity of a cultivated science.

"A few rough memoranda or figures, to yield a gross account of the general receipt or payment, are usually the greatest exertions that common farmers, who pretend to keep accounts, make in this line.

"The advantages of clear accounts are obvious in every other pursuit in life: and to conduct those of a merchant, by the Italian method of double entry, has been an essential branch of education for the classes intended



tended for commerce. Men engaged in large speculations who are not regular in their accounts, are always supposed, by the prudent part of the world, to be in a dangerous situation; nor is there a greater reproach to a merchant, short of actual bankruptcy.

“ But agriculture is destined to be, in all its detail, an exception to every thing else. Men engage in it without previous education, or even study or inquiry; and they conduct large concerns in it without those accounts known to be necessary in every other pursuit. With the lowest and most uneducated farmers this is pardonable; but what excuse have gentlemen for such a conduct?

It should be remembered, that experimental agriculture, or even these ideas, more or less detailed, which we meet in conversation, must depend for their justness very much on the accuracy of accounts. For a supposition deduced from general observation on a farm, and grossly conceived, must fall exceedingly short for correctness of the regular detail of exact accounts.

“ The general fact is however admitted, and accordingly it is common to hear gentlemen speak of their accounts. But, unfortunately, they are usually kept in such a manner as to prove rather the means of fortifying prejudices than removing errors. All those questions of nicety where the contrasts are not exceedingly strong, relative to the comparative profit of different soils, of different courses, of different applications of the same soil, of different modes of culture, &c. depend entirely on accounts. Keep your accounts in the mode of one man, grass is more profitable than tillage; keep them in a different method, and the contrary shall be the result. The variety in the mode of

N 3 keeping

Obstacles to Agriculture. keeping these accounts is very great, and even among gentlemen of considerable attention, carefulness, and accuracy.

" This comes from the great and undoubted difficulties which rise in a thousand forms, whenever an attempt is made at positive accuracy. They are not imaginary, but real difficulties, and such as will demand a very considerable attention to obviate. I have reflected on the subject for many years; and they are few in which I have been satisfied with my approach towards accuracy. For while there are distinctions that must everywhere be kept up, there are many minutiae that must be sacrificed, in order to render the account tolerably easy to keep without an attention that a man in an active line of life cannot give. To keep to this medium is the great difficulty.

" The nature of the farm must in some instances regulate the mode of the accounts. Suppose a man has the evil of an open field, or with scraps and bits of land scattered among his neighbours; in such a case it is impossible for him to keep an account for every field: and yet this is one of the most indispensable points that in general must be adhered to; for he who does not know what every field has paid him, is deficient in the very foundation of experience. In this light all little fields on a large farm are nuisances; they derange accounts entirely if the greatest attention is not paid, and they are as inconvenient in cultivation, and attended with as much loss in headlands and borders, as they are ruinous to any exactness of account.

" But as many persons keep accounts without attending to this point, I would observe, that when all the wheat, all the barley, all the oats, &c. are respectively

tively thrown together, some very essential objects of experience depend on ^{Obstacles to Agriculture} guesses which ought to be ascertained correctly. Has fallow, or clover, or beans, paid best, as preparations for wheat? How is that question to be answered if all are huddled together in one barn or stack, and meet in the same account? *The farmer can guess nearly.* He may: but go to a chemist, a physician, or a mathematician, and ask them if their sciences were pushed to their present perfection by accepting such guesses instead of experiment? Besides, they are in their nature quite uncertain; and when a comparison is formed by two guesses, a very little error in each will amount to so much in both as to overturn all authority. Another point is, a man's guess being influenced by a favourite theory: a rigid friend to fallows, when he draws, by guess, a comparison between them and beans, will be apt, in the nature of things, to be partial: he should not put himself in the situation. He who would abhor the idea of falsifying a fact that is before him, might guess, at least, without sufficient accuracy.

" If the fields are not very small, the inconvenience of keeping crops separate is little. Stacking corn is by far better understood and executed in the isle of Wight than in any other part of the kingdom: a great stack is rarely to be seen there; a farmer that has 500 acres of corn, has none but small ones. With such, accounts are kept separate with great facility; at least, if there are difficulties in it, there are others we shall meet with abundantly greater.

" To sow one field with several crops at the same time, part wheat, part clover, &c. is very bad and inconvenient management, and ought to be avoided, were

Obstacles to Agriculture. accounts out of the question. If it cannot be shunned they must necessarily be more complex.

“ The first object in keeping accounts is to ascertain the expenses in order to divide them properly—Rent, tythe, and parish taxes.

“ These articles demand three accounts to be kept separate; but they are all to be arranged on the same principle. The amount of the two last, when known, which is at the end of the year, must, like the rent, be divided over every field for which an account is kept: this is very easy when the measure of the fields is known. I need not observe, that the farmer in dividing the rent should do it as exactly and as fairly as possible, and that the two other articles should be proportioned to the rent.

“ But here occurs one difficulty, which is, I confess puzzling. It is the difference between the gross and the neat measure of the fields of an inclosed farm. The hedges, ditches, and borders, take up in many farms a considerable portion of the field; from an eighth to a twelfth; and in some even more. Now if they are reckoned, and accounted for as part of the field; then the acreable produce is affected, and even the profit of the husbandry, by a circumstance not essentially connected with it; and if two fields are compared in their husbandry, that may be most advantageous which has least border, and for that reason; which would derange a comparison entirely. I know but one way of getting rid of this difficulty, which is, to measure the neat contents where the plough goes in an arable field, and where the scythe goes in a grass one; and then deducting the total of those measures from the gross contents of the farm, throw the difference into one account by itself

itself under the title of fences and borders ; to which account must be charged the proportion of rent, tythe, and parish taxes. If wood is cut or grubbed from these borders, or grass is mown from them, the value of the wood or hay to be credited ; the expence of the fences to be charged ; and the balance of the whole, for it may everywhere be expected to prove a losing account considered as the expence of fences and acreably, divided over the whole farm, like rent, tythe, or parish taxes. The only person who ever had an attention to this accuracy was Mr Baker, experimenter to the Dublin Society. He published a map of his farm, with the gross and neat contents of every field. For want of observing this precaution, many experiments have been made, and many conclusions drawn which are mere errors.

“ *Sundry expences* may be the title of an account which must have place on every farm. Whatever payments concern the farm in general, and not any field or object in particular, and are not included in the preceding articles, must be entered under this title. Instances are, a bailiff’s salary, payments to rat or molecatchers, mending roads upon the farm, expences at market, &c. &c.

“ *Wear and tear* includes all payments to blacksmith, carpenter, wheelwright, harnessmaker, &c. But in the division of this article there must be a variation from the preceding : they are divided over the whole farm ; but these must be proportioned differently ; the arable lands will absorb the greatest part of these expences ; mowing grass very little ; and feeding grass still less. But to avoid any arbitrary estimation when a rule can be established ; the proper mode of dividing this

Obstacles to Agriculture. this expence per acre will be by making the expence of the teams a rule for it ; to find how much per cent. or in the pound of the team-account, this expence of wear and tear amounts to, and charge it accordingly.

“ The team-account is that which is in general more mistaken than any other on a farm. Nothing is more common than every day to see accounts in which ploughing is charged at 4s. an acre, or at 5s. or at 10s. or whatever may be the hiring price of the country ; but few words are necessary to shew that this is entirely fallacious ; it is probably much under the real expence. Every practical farmer must know that the way to have cheap tillage is to keep the teams well employed : when a man’s own work is done, his team stands still, if he does not employ it for his neighbours ; to do which, he will work for them below the value, and yet find some advantage in it. In consequence of such a conduct being common, to say that such is the price of tillage can never be accurate. It has by no means that best accuracy of *price*, because you cannot buy your commodity when you want it ; and he who depended on the market for all the work of his farm would soon find the state of his fields calling for a very different system.

“ The means of ascertaining the real expence of all team-work is very obvious ; but depends totally and absolutely on accurate accounts. So much in summer for their green food ; so much hay and oats eaten ; so much for shoeing and farrier ; so much for the actual decline of value ; and so much in labour for attendance, give the real expence of the team. In order to divide this total expence among the work executed, a day-book is necessary, which a man may keep himself, or trust to his bailiff,

bailiff, as he pleases. It must contain the work of the teams and men every day in the year, specifying the field or business they are employed in. At the end of the year the amount of the expence is proportionally divided among the work, and the clearest truth and correctness are necessarily the result.

" I ought to observe, that this accuracy is very desirable for ascertaining various circumstances. The comparative profit of grass and arable land depends much on it. Some persons, from too lightly estimating the expence of teams, think arable the most profitable; and others, whose calculation of those charges runs perhaps too high, give too much into the counter opinion. I can easily conceive that many strenuous advocates for fallows might lose a little of their warmth, if they knew what the expence of ploughing an acre of land really was on their farms. Such instances might be multiplied; they are indeed obvious to every man capable of uniting the theory with the practice of a business.

" The article of manure is much more complex; and, upon the whole, the most difficult account there is for a farmer to keep. It must be arranged under the title *farm-yard*; and it connects with so many objects, that no little care is necessary to keep it, and with the greatest attention some doubts will still remain.

" Suppose the system to be that of carting a stratum of marl over the yard before foddering begins; that expence is to be ascertained at once without any difficulty; but how is the straw to be charged? cattle may be put out to straw in this country at 9d. a-week, and some at 6d. At these prices a ton will pay about 5s.; but while the cattle may be thus supported, the farmer
may

~~Obstacles to Agriculture.~~ may buy straw with a view to the dung at 15s. and 18s. and even 20s a ton. This contrast is difficult to settle. The price per week is arbitrary though actual; men take them at those rates, because they have none or not enough of their own; and it is not ascertained as the value which cattle will really pay for the straw, which may be more or may be less. The whole is uncertain.

“But with the straw of one’s own crop there is a double difficulty, because there must be two valuations instead of one. We must reckon so much an acre or load for it, and so much a week for the cattle that eat it; but both are suppositions. Among counter objections one must choose the least. The best method perhaps is to charge the *farm-yard* account with the price of the straw, at which it could be sold, deducting the expence of carrying it out; and to credit the same account with the price per week of keeping the cattle; which price is charged to the debtor side of the cattle account, as part of the expences of keeping them. Whatever labour is bestowed on the dung, in shovelling and cleaning yards, throwing up the urine, turning over, &c. is charged of course to it. When the whole is carted on the land, the total expence is divided by the number of loads, and the price per load ascertained. It is charged the year following (as the time consumed will make that delay necessary) to the account of the fields on which it is spread; and though the whole advantage is by no means exhausted by the crop, yet the whole expence must be charged to the crop that receives it, or the accounts would be kept open so long as to create confusion.

“The time of balancing the books every year should be that of entering the farm. This is most usual at Michaelmas, but the crop of the year is not then disposed of,

of. To avoid valuations which ought never to be relied on when certainty can possibly be gained, the old year's accounts are to be kept open long after the new year's ones are begun; that is, till the corn is all threshed and sold, till the fattening beasts are gone, and till all these circumstances are decided which relate to the preceding year. This is essential to exact accounts, and can by no means be dispensed with. In this case, valuations may be totally rejected; but there are others in which no management can exclude them: these are, in *live stock* not bought and sold within the year, and *implements*.

"A man may stock his farm with cows at 10l. a piece; but if he supposes them some years after to be worth the same sum, he will grossly deceive himself. He must value them every year, and also the young stock which he rears with a view to keep up the number or for sale; and the rule by which he should make the valuation ought to be the price they would sell for at the moment. The same management must direct him with succession beasts, bought or bred for fattening, and also with a flock of sheep. On which last head I must observe, that the want of keeping such accounts as I am describing, is alone the reason for a difference of opinion relating to the profit of sheep. Can any thing be a clearer proof of the barbarity of accounts as they are kept at present by stock-masters, than the surprising question once in agitation among them, whether they gain or lose by their flocks, a question that has arisen from Mr Macro's paper on that subject published in this work. Such uncertainty could not obtain if farmers kept regular accounts. The description of the profits of a flock not being properly a calculation, but an account,

Obstacles account, it ought to be transcribed from a man's private books. Unfortunately they are kept in such a manner that difficulties multiply at every step in the endeavour to understand them.

" Implements must all be valued every year; and the balance, being the expence, carried to the wear and tear account which it makes part of.

" One of the most complex and difficult accounts, if not the most so of all, is that of grazed lands fed; it involves itself with cattle of all kinds, with hay, with the team, &c. and in such a manner as to make an accurate separation very difficult. How is the value of the feed to be calculated? If 2s. a week for a cow or bullock, or 3d. for a sheep is charged, it is merely arbitrary. Mr Macro has shewed us, by his grazing account, that such estimates are to the last degree fallacious. They imply profits, but allow nothing for losses. On the other hand, if the actual profit or loss on the live stock be made the product; in that case, the grazed land must be made a mere cattle account. There are obvious objections to this; but it is, upon the whole, much less objectionable than a valuation per week, which must, in the nature of it, lead to nothing but error. On this principle the account must be kept in the following manner.

" One account opened for *mowing ground*, in which the rent, tythe, taxes, and all expences in one total for every field mown, are carried to this account; and the credit of it to consist of the value at the market price, (carriage deducted) of the hay mown as delivered to the team, fatting beasts, cows, sheep, &c. which several accounts are debited with their respective consumptions.

" But the fields which are mown have also an after-graft,

grafs, which is fed ; this must of necessity be valued at ^{Obstacles} so much an acre, and charged to the account of the ^{to Agricul-} *feeding ground*. There is no choice in this case, for any ^{ture.} other mode would create confusion.

“ That account of *feeding ground* comes next. All the total debits of the fields fed must be carried to it. The credit side to consist of the food of the teams charged at the price per week, suppose 2s. and of that of any cattle taken in to joist. These articles ascertain themselves, but those which result from profit on stock kept are not so easily discovered.

“ There is further a *sheep* account, a *dairy* one, and another for *fatting beasts*. In these are to be charged all the expences peculiar to those articles,—shepherds wages, hurdles, market expences, &c. to the sheep ; dairy fed, fuel, straw yard, &c. to the cows ; and the purchase money of lean stock to fatting beasts.

“ Here, therefore, at the end of the year, lies open before the accountant, five or six or more unsettled accounts, not one of which can be closed but by reference to each other. Hence arises the great complexity of the farmer’s accounts ; but amidst this apparent confusion, order must be made to arise, or all our labour is vain.

“ Further, the fatting beasts are put to turnips : the cows have turnips, the sheep have turnips ; how is this to be accounted for ? This creates a new difficulty, but we must examine the best mode of clearing it.

“ If the cattle-account is charged with the prime cost of the turnips, that is, with the expence of cultivating them, it will by no means be fair, for the expence is usually greater than the value ; and a man may in a turnip country buy them cheaper than he can cultivate

Obstacles ~~to Agriculture.~~ vate them : he submits to a known loss, because ~~he~~ knows he will be more than repaid in the barley that follows them ; but to transfer this loss to the cattle, would be unfair. The plain way of proceeding, therefore, is to value the turnips at what they would sell for, and to debit the cattle-accounts with their respective consumptions. But there are two prices of turnips : one for carrying the crop on to another man's land ; the other, for eating them in the field. The latter ought to be the rate chosen on this occasion, charging the cattle with the labour and expences of carriage.

" That there is a complexity in this mode of arranging the accounts of live-stock is beyond doubt ; but after the steadiest and most reflected attention that I have been able to give it, I can see no mode of simplifying it. Submit to the rules here laid down, and you have the satisfaction of all the accuracy that is attainable ; but in any other method it will remain unknown, whether the profit or the loss belongs to the land or to the stock that feeds upon it.

" I am clear this method will be rejected by those who only read this paper in a common transitory manner, without studiously examining all the points on which the arrangement depends ; but to such as will reflect on what they read, and give the due attention, I have little doubt but this method will appear the only clear and satisfactory one.

" When so much profit is actually made, to divide it by a weekly account to the fields that fed the stock, is making an easy calculation with full data before you ; but to charge the stock with so much per week for feeding certain fields when you do not know but the ac-

count of stock may be loss, not profit, is calculating without any better data than mere supposition.

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ture.

“ Such are, I apprehend, the principal difficulties in keeping the accounts of a farm. I do not offer the mode as one that obviates all objections. I do not conceive it possible to obviate all ; but I think that fewer sources of inaccuracy will be found in it than in any other.”

A second obstacle to agricultural improvement, consists of the poverty of the husbandman, or of his want of capital, to enable him fully and completely to labour the soil, and provide materials for its amelioration. Complaints have often been made with little reason, of the obstinacy of farmers, and of the tenacious manner in which they adhere to old practices, though demonstrated to be improper : But a poor man cannot afford to make experiments, or to hazard the loss of a crop for the chance of obtaining a more valuable one by some untried practice. In consequence of want of capital, large portions of territory remain in some parts of the country in a state of nature, and consequently unproductive, both to the occupier and to the proprietor. Both landlords and tenants, therefore, ought to know, that a man who engages in agriculture without a sufficient capital takes up a bad trade, in which something may be lost by both parties by the deterioration both of the soil and of the stock upon it, but from which neither the public nor themselves can derive profit.

It is difficult to point out the precise extent of capital which a man ought to possess, to entitle him to engage in agriculture. This must necessarily vary according to the circumstances and situation of particular districts ; and we can only propose here to state the general principles

Obstacles to Agriculture. ciples which ought to be under the view of a man of sense, while considering this important question. We need say nothing of the necessity which is incumbent not only upon the husbandman, but upon all persons engaging in commerce, manufactures, or any other employment, to make provision for the first outlay of stock and expence of labour necessary to be encountered before the profits of the business enable it to support itself. We pass over this original expence, because it has nothing peculiar to agriculture, and because its amount must depend upon the extent of the farm occupied, and the manner in which it is to be cultivated. To these last points only, therefore, we shall request attention.

A man about to engage in agriculture ought to possess sufficient capital to enable him to occupy a farm of such size, as will put it in his power to do justice to himself, while, at the same time, he does full justice to the soil of which he obtains possession : that is to say, he ought, in the first place, to have sufficient funds wherewith to stock and labour a farm of such magnitude, as will sufficiently occupy his whole time. If his farm be so small as to leave him unemployed for weeks or for months during the year, he can only be said to be a farmer at a time, or occasionally. At other periods he is either a man without a trade, that is, an idle man, whose existence is so far useless to himself and to the community ; or he must engage in other employments, which will withdraw his attention from his principal business, and so far diminish the interest he takes in its success, as to render it far less likely to prosper in his hands than it otherwise would have been.

A person proposing to engage in agriculture ought not to evade the objection against too small a farm, by proposing

proposing to labour himself like one of his servants. Obstacles to Agriculture. A man of good education, which a farmer ought to be, misemploys his faculties when he engages in the constant drudgery of manual labour; nor will he be qualified to fulfil properly the duties of his situation, if he occupy himself in this manner. Farming is a liberal art, and consists in appointing and in superintending labour; in keeping a record of its result, and in devising means for laying it out hereafter to better advantage. Were the farmer to hold his own plough, and perform other menial services, he could not have time to make observations, to think, to read, to go to markets, to meet with his neighbours, to ride through the parish, and county, and neighbouring counties. Farming is the most difficult of all the arts; and, as already mentioned, nothing has retarded its advances so much as one farmer not knowing what another is doing at a distance from him. It is by no means here insinuated, that a farmer ought to be ignorant of labour or averse to it. On the contrary, he ought to be able to hold the plough, to reap, to build and stack, and to perform every other agricultural operation. He ought not only to be qualified to perform these operations, but he ought actually to engage in them with alacrity upon every press of business, not only for the sake of having the work done, but to render the labour in which they are employed respectable and important in the opinion of his servants, and to induce them to proceed in it with cheerfulness and vigour, which his example will have no small tendency to accomplish. The general rule, however, with regard to a farmer's situation is this, that he ought to be regarded as the superintending head of a manufactory requiring more vigilant attention than other manufac-

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ture.

tories ; because the business from its nature cannot be conducted in a mechanical train, but requires a change of operations and management according to the variation of seasons and circumstances. If a man have not sufficient capital to enable him to occupy a farm which will place him in such a state of continued superintendence, it is evident that he does injustice to himself, and throws away his time by engaging in such a profession.

At the same time it is to be observed, that a man acts very improperly, who attempts to occupy a larger farm than his capital will enable him to manage with propriety and success. The perfection of agriculture consists, in ordinary cases, of labouring the soil by the most perfect and frequent tillage, and of enriching it by large quantities of manure. With regard to the former of these, it evidently cannot be accomplished, without obtaining, at whatever price they may cost, the best horses, the most skilful farm servants, and the best ploughs or other instruments of husbandry. An extraordinary outlay of money is also sometimes necessary. It frequently happens that a soil is in a state unfit to produce valuable crops, which might nevertheless, by an expence which it would amply repay, be speedily rendered extremely fertile ; as in the case of lands that require to be drained, or of lands so situated as to admit of a stream of water being periodically poured over their surface. It is evident, that a man commits a crime against society who attempts to farm such lands, without possessing sufficient capital to enable him to do them justice by introducing these improvements.

With regard to the importance of repairing the exhausted

hausted powers of the soil by abundance of manure, and of the necessity of a farmer possessing sufficient capital to enable him to do so, too much cannot possibly be said. Nature is extremely grateful for every care bestowed upon the soil in this respect: not only does she repay with manifold interest on ordinary occasions every expence of manure, however profusely laid out, but she even places the agriculturist who acts liberally in this way, in some measure beyond the reach of fortune. In calamitous seasons, when nations suffer in consequence of sterility, the farmer whose lands are in excellent condition, by being richly manured, seldom fails to reap two-thirds of his usual crop, for which he receives perhaps three times the ordinary price; while other husbandmen, possessing less skilful industry or less capital, have to regret the total unproductiveness of their fields.

The expence of providing manure may be different in different situations. In the neighbourhood of great cities it may amount to nothing more than the sum that is paid for it; but at a distance from these it becomes necessary for the farmer to be at the expence of purchasing, perhaps at a very high rate, a large stock of cattle, and to rear suitable crops of turnips, &c. for their food, that he may be enabled to enrich his lands by their dung. It may indeed be justly said, that in proportion to the quantity of cattle thus kept on a certain extent of soil for the purpose of renovating its fertility, and enabling it to produce heavy crops of grain, may the perfection to which the agriculture of any country has attained be fairly estimated.

In short, it is only by men possessing a considerable capital, that agriculture can be improved or carried on

in such a manner, as to bring any portion of soil to its utmost degree of fertility. What Arthur Young, Esq.* has said of small farms and small farmers applies, in truth, to farmers destitute of sufficient capital. "Let me demand of the advocates for small farms," says this writer, "where the little farmer is to be found who will cover his whole farm with manure at the rate of 400 or 150 tons per acre; who will drain all his lands at the expence of two or three pounds an acre; who will pay a heavy price for the manure of towns, and convey it 30 miles by land carriage; who will fence his meadows at the expence of 50 per acre; who, to improve the breed of his sheep, will give 1000 guineas for the use of a single ram for a single season; who will give 25 guineas per cow for being covered by a fine bull; who will send across the kingdom to distant provinces for new implements, and for men to use them; who employ and pay men for residing in provinces, where practices are found which they want to introduce on their farms? At the very mention of such exertions, common in England, what mind can be so perversely framed as to imagine, for a single moment, that such things are to be effected by little farmers? Deduct from agriculture all the practices that have made it flourishing in this island, and you have precisely the management of small farms."

We may farther mention, that a farmer ought to possess sufficient capital, or sufficient credit, to enable him to retain in his possession his crop during six or eight months after it is reaped. It is necessary, both for his

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* *Travels into France*, vol. i.

own interest, and for the interest of the public, that he should have it in his power to do so. He himself cannot possibly expect to receive the best prices, nor consequently to obtain the just profit which ought to result from his profession, if he is under the necessity of instantly bringing to sale the produce of his farm, without being able to wait for the best state of the market. In a country in which commercial speculations are prevalent, it is extremely necessary, that farmers should be able to keep back their grain for a time from the market, for the sake of protecting the public against the combinations of monopolizing speculators. Farmers themselves are always too numerous a body to be able to injure the public by improper combinations to raise the price of grain; but if they were in general needy men, under the necessity of bringing their produce to market at the conclusion of the harvest, there would exist no means of preventing combinations of monied men from obtaining at all times a complete command over the price of provisions, and producing an artificial scarcity by buying up the grain.

A third obstacle to agricultural improvement sometimes arises from the possessor of the soil not having a sufficient interest in it. In barbarous nations, lands are often possessed by communities as an undivided property, without any individual member having an exclusive right to a particular spot. In such cases, the worst kind of agriculture must always prevail; for the same reason that public affairs are always worse managed than the affairs of private persons, who find their industry stimulated not merely by a sense of duty, but by the influence of avarice, and of all the other selfish passions. Considerable portions of territory in Eng-

Obstacles land still remain withheld from the exertions of an ^{im-}
to Agriculture. proving agriculture by this state of property. But,
even where the interest which the cultivator has in the
soil is exclusive, it may still be too limited. Where a
landlord is prevented by an entail, or other family set-
tlement, or by narrow prejudices and a short-sighted
policy, from granting leases of a proper endurance, it
is never likely that the soil can be well cultivated.
Every outgoing farmer will endeavour, during the last
years of his lease, to do as little for the land as pos-
sible, and to take from it all that he can possibly ob-
tain. The first years of every new lease will there-
fore be spent by every new farmer in repairing the da-
mage done by his predecessor. Scarcely, however, has
he accomplished this object, when he himself, if his
lease be short, must set about procuring indemnity for
the money he has laid out in ameliorating the soil, by
scourging it in his turn, or by taking from it as heavy
crops as possible, and by bestowing upon it little or no
expence.

Still worse than the situation of the farmer with a
short lease, is the state of him who enjoys no lease at all.
A man with his hands tied behind set to labour the
ground is not more absurd than for a farmer to conduct
the business of husbandry without a lease; and yet such
men there are under the name of farmers in the greater
part of England. Every scheme, in this case, must end
with the year; nothing that reaches the future, or is
to last for a great number of years, can be attempted,
although this be what is chiefly wanted in the present
imperfect state of agriculture; and what is worse, the
lands are not only unimproved, but the farmer is under
the strongest temptation to exhaust them. It is difficult

to say, whether this be a greater evil in small or in large farms, although in small ones probably it is most bane-^{Obstacles}
ful; there being, in a cluster of small farms, a greater number of hands and heads at work to spoil the land than in one large one. Here it is not so much idleness that is to be dreaded as mischief. The great and unanswerable argument to be used with landlords in favour of leases and unrestriciting clauses is, that ~~they~~ ^{they} would taste first and most plentifully of the sweets of an increased rent. When the case is otherwife, the public are deprived of much, but the landlord of more; for his own station being in the middle, between his tenants on the one hand, and the public on the other, receiving from the former, and communicating to the latter, a great share of the enjoyment uniformly centres and remains with himself; and hence, the smaller the produce on his estate, from denying security and freedom to his tenants, the more sensibly small will be his share.

With regard to restrictions in the management of the soil, it is a good general rule, that a man of sufficient capital who engages in the cultivation of an arable farm ought to submit to none, excepting perhaps during the last years of his lease. Landlords have frequently attempted to substitute their own skill in place of that of the farmer, and by restrictive clauses in the lease to tie him down to a mode of cultivation which they thought most profitable for himself and advantageous to the land. In this way, however, the progress of improvement is arrested. By superior skill being rendered of no value to the tenant, he endeavours not to acquire it. A slovenly husbandry infallibly takes place, accompanied

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Obstacles in all probability with bad temper on the part both of the landlord and tenant; the one endeavouring to enforce, and the other to evade, the stipulations of the contract. The temptation is indeed, so great, to exhaust a soil during the last years of a lease, that it becomes necessary to the interest of the public and of the landlord, that the mode of cropping should be regulated during these last years. Beyond this point, however, a man of spirit engaging in agriculture, ought not to suffer himself to be fettered, but ought to secure for himself an opportunity of making use of whatever additional improvements his art may receive, either from the enterprises of others, or from his own increasing skill and experience.

Under the same head of a want of proper interest in the soil, may be enumerated the payment of tithes, of which in England every farmer so grievously complains. Whatever money the husbandman may there lay out in improvements, is not expended for himself; as the proprietor of the tithes is entitled to draw a share of the whole additional increase, and thus becomes a partner in the profits of the enterprise, without running any risk of loss by its failure. The odium of this tax, is said to induce great numbers of husbandmen to continue their lands in pasturage, to the no small detriment of the public, from the comparative unproductiveness of human food, which attends that mode of occupying the soil. Fortunately in Scotland this evil has been removed, by the wisdom of our forefathers, as every landlord possesses the privilege of obtaining his tithes to be fixed at a settled rate of payment for ever; and, in many cases, of having his lands alto-

ther disburdened, upon payment of a very moderate Obstacles
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ture. price.

The progress of the art of agriculture in Europe was long retarded by the want of respectability which attended it, when engaged in as a profession or trade from which profit was to be derived. In the feudal times, the military profession was the only employment in which a layman of liberal education could respectably engage. Agriculture, the only art which is absolutely necessary to the existence of man, was regarded with contempt, and left in the hands of the meanest of the people. Even the most ordinary mechanics were considered as superior to persons whose employment it was ; because the mechanic, residing in a town, and usually under the protection of the prince, was safe from the dominion and the insults of the petty chieftains that ruled in every part of the open country. The state of affairs is now greatly altered in this respect : More enlightened views, and a better state of society, have restored to the profession of agriculture the respectability which naturally belongs to it. It must be acknowledged, however, that the recent improvements which have taken place in the art, have contributed not a little to this change in the sentiments of mankind concerning the persons occupied in it. It is now found, that a man may become rich by agriculture, and that there are few better ways in which a prudent and industrious man can lay out a moderate capital. In a commercial age, the path that leads to wealth is always respected and accounted honourable, and accordingly it is now not unusual for the sons of British noblemen, and gentlemen of extensive fortunes, to become apprentices to farmers.

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Obstacles to Agriculture. The last obstacle to agricultural improvements, of which we shall take notice, arises in some countries from the want of judicious legislation, or proper arrangements made by the public in its favour. The produce of the art of the husbandman, and the manures for which his lands have occasion, are all bulky commodities, which cannot be transported without labour and expence. Unless care is taken, therefore, to prepare and maintain good roads throughout the country, the profits of agriculture must always be subjected to such deductions as will greatly retard its prosperity. In the same manner, if the state, from any narrow policy, shall prevent the husbandman from bringing his goods to the best market, by exportation or otherwise, it is impossible that his art can flourish. In former times, nations were afraid to permit the exportation of grain, even in seasons of plenty, lest they should be left without food, not considering that the surest mode of producing abundance of any commodity consists in offering, at all times, a good price for it. This error is now rectified in most nations; and at all events, in the present state of affairs, the British husbandman has no reason to complain, as the grain reared in this country is, even in the best seasons, understood to be inadequate to afford subsistence to its inhabitants.

PRACTICE

PRACTICE

OF

AGRICULTURE.

THE practice of agriculture naturally divides itself Division of
the subject into three parts: 1st, The cultivation of vegetable food for men and animals; 2dly, The cultivation of vegetables, such as flax and hemp, which are more properly articles of commerce; and 3dly, The rearing and management of animals. To these we shall add, as connected with all the branches of agriculture, a short description of the most usual modes of fencing and enclosing lands for cattle and other objects of husbandry.

PART

PART I.

OF THE CULTIVATION OF VEGETABLE FOOD.

Cultivation
of vegeta-
bles divided
into four
branches. **W**E shall consider this branch of the subject under four divisions. In the first we shall present to the reader a statement of the most useful instruments of agriculture. 2dly, We shall state the mode of preparing land for cropping, by removing the physical obstructions to agriculture, and reducing the soil into a proper state. 3dly, We shall explain the culture of particular plants, and the practices of husbandry connected with it ; and, lastly, We shall state the principles and operations of the horshoeing or drill husbandry.

SECT. I.

INSTRUMENTS OF HUSBANDRY.

THE instruments employed in agriculture are various ; as the plough, the harrow, the roller, &c, which are again diversified by various constructions adapted to particular uses.

1. Of Ploughs.

The plough The plough is a machine for turning up the soil by the action of cattle, contrived to save the time, labour,

and expence, which, without this instrument, must have been employed in digging the ground, and fitting it for receiving all sorts of seeds.

Amidst all the varieties which can occur in the manner of ploughing the ground, arising from difference of soil, local habits, and other causes, there is still a sameness in the task which gives a certain uniformity to the chief parts of the instrument, and should therefore furnish principles for its construction. There is not, perhaps, any invention of man that more highly merits our utmost endeavours to bring it to perfection ; but it has been too much neglected by those persons who study mechanics, and has been considered as a rude tool, unworthy of their attention. Any thing appears to them sufficient for the clumsy task of turning up the ground ; and they cannot imagine that there can be any nicety in a business which is successfully performed by the ignorant peasant. Others acknowledge the value of the machine, and the difficulty of the subject ; but they think that difficulty insuperable, because the operation is so complicated, and the resistances to be overcome so uncertain, or so little understood, that we cannot discover any unequivocal principle, and must look for improvement only from experience or chance.

But these opinions are ill founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artist that we can expect improvement. It requires the serious consideration of the most accomplished mechanician ; but from him we *may* expect improvement. We have many data : we know pretty distinctly what preparation will fit the ground for being the proper receptacle for the seed, and for supporting and nourishing the plants ; and though it is, perhaps, impossible

Instruments impossible to bring it into this state by the operation of any instrument of the plough kind, we know that some ploughs prodigiously excel others in reducing the stiff ground to that uniform crumbling state in which it can be left by the spade. The imperfections of their performance, or what yet remains to be done to bring the ground to this state, is distinctly understood. It seems, then, a determinate problem (to use the language of mathematicians), because the operation depends on the invariable laws of mechanical nature.

The task it performs. It will therefore be very proper under this article, to ascertain, if possible, what a plough in general ought to be, by describing distinctly its task. This will surely point out a general form, the chief features of which must be found under every variety that can arise from particular circumstances.

The plough performs its task, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform state into which we can bring it by the spade; but we wish to bring it into such a state that the ordinary operations of the season will complete the task.

For this purpose, a slice or sod must be cut off from the firm land. This must be shov'd to one side, that the plough and the ploughman may proceed in their labour; and the sod must be turned over, so that the grass and stubble may be buried and rot, and that fresh soil may be brought to the surface; and all must be left in such a loose and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The first office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the stock follows this,

this, and its edge gets under the sod, and lifts it up. Instruments While lifting it up, it also heels it over, away from the firm land. The mouldboard comes last, and pushes it aside, and gradually turns it over as far as is required.

The general form of the body of a plough is that of a wedge, or very blunt chisel, AFEDBC, (fig. 1.), having the lower corner D of its edge considerably more advanced than the upper corner B; the edge BD and the whole back AFDB is the same perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and square at F; the surface BCED is of a complicated shape, generally hollow, because the angle ABC is always greater than FDE: this consequence will be easily seen by the mathematician. The back is usually called the LAND SIDE by the ploughman, and the base FDE is called the SOLE, and FE the HEEL, and BCED the MOULD-BOARD. Lastly, The angle AFE is generally square, or a right angle, so that the sole has level both as to length and breadth.

By comparing this form with attention, the reader will perceive that if this wedge is pulled or pushed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previously made by the coulter, the point D will both raise the earth and shove it to one side and twist it over; and, when the point has advanced from F to D, the sod, which formerly rested on the triangle DFE, will be forced up along the surface BCED, the line DF rising into the position Df, and the line EF into the position Ef.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mouldboard, in the position DfE: the slice, thus deranged from its former

Instruments situation, will have a shape something like that represented in fig. 2.

A fundamental maxim in the construction of a plough.

In as much as the wedge raises the earth, the earth presses down the wedge; and as the wedge pushes the earth to the right hand, the earth presses the wedge to the left; and in this manner the plough is strongly pressed, both to the bottom of the furrow by its sole, and also to the firm land by its back or land side. In short, it is strongly squeezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane $a\ b\ DF$ and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a resisting support, by which it can perform all parts of its task. We beg our readers to

keep this circumstance constantly in mind. It evidently suggests a fundamental maxim in the construction, namely, to make the land side of the plough an exact plane, and to make the sole, if not plane, at least straight from point to heel. Any projection would tear up the supporting planes, destroy the directing groove, and expend force in doing mischief.

This wedge is seldom made of one piece. To give it the necessary width for removing the earth would require a huge block of timber. It is therefore usually framed of several pieces, which we shall only mention in order to have the language of the art. Fig. 3. represents the land side of a plough, such as those made by James Small at Rosebank, near Foord, Mid Lothian. The several parts of the plough. The base of it, CM, is a piece of hard wood, pointed before at C to receive a hollow shoeing of iron CO, called the SOCK, and tapering a little towards the hinder end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, just behind the fock,

sock, is mortised a sloping post, AL, called the **SHEATH**, Instruments of Husbandry. the front of which is worked sharp, forming the edge of the wedge. Nearer the heel there is mortised another piece, PQ, sloping far back, called the **STILT**, serving for a handle to the ploughman. The upper end of the sheath is mortised into the long **BEAM** RH, which projects forward, almost horizontally, and is mortised behind into the stilt. To the fore end of the beam are the cattle attached. The whole of this side of the wedge is fashioned into one plain surface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The **COULTER**, WFE, is firmly fixed by its shank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about six inches before the point of the sock. It is brought into the same vertical plane with the land side of the plough, by giving it a knee outward immediately below the beam, and then kneeing it again downward. It is further supported on this side by an iron stay FH, which turns on a pin at F, passes through an eye-bolt I on the side of the beam, and has a nut screwed on it immediately above. When screwed to its proper slope, it is firmly wedged behind and before the shank. Fig. 4. represents the same plough viewed from above. ST is the right hand or small stilt fixed to the inside of the mouldboard LV.

Fig. 5. represents the bottom of the wedge. CM is the head, covered at the point by the sock. Just behind the sock there is mortised into the side of the head a smaller piece DE, called the wrest, making an angle of 16° with the land side of the head, and its outside edge is in the same straight line with the side of the sock. From the point to the heel of the head is about

Instruments 33 inches, and the extreme breadth of the heel is about ^{of Hulban-} nine. The side of the wedge, called the furrow side, is ^{dry.} formed by the mouldboard, which is either made of a block or plank of wood, or of a thick iron plate.

Socks. The sock drawn in this figure is called a SPEAR SOCK, and is chiefly used in coarse or stony ground, which requires great force to break it up. Another form of the sock is represented in fig. 6. of the same plate. This is called a FEATHER SOCK, and has a cutting edge C on its furrow side, extending back about ten inches, and to the right hand or furrow side about six. The use of this is to cut the sod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great use when the ground is bound together by knotted roots, but it is evident that it cannot be used to advantage in very stony ground. In general, the feather sock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of separating the sod. It may reasonably be asked, why the feather is not much broader, so as to cut the whole breadth of the furrow? This is sometimes done. But we must recollect that the sod is not only to be pushed aside, but also to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the sock, it would only be pushed aside; but by leaving a little of the sod uncut, it is held fast below while it is shoved aside above, which cannot fail to twist it round. As the wrost advances, it easily destroys the remaining connexion, which in general is very slight and crumbling.

Proper breadth of the sole. The breadth of the sole at the heel determines the width of the furrow. Nine inches will give enough room for a horse or man to walk in. A greater breadth is

is of no use, and it expends force in pushing the earth ^{Instruments} _{of Husbandry.} aside. It is a mistake to suppose that a broad sole gives more room for the turned slice to stand on; for whatever is the breadth of the furrow, the successive slices will be left at their former distances, because each is shoved aside at the same distance. When the breadth of a slice exceeds its depth, and it is turned on its side, it will now stand on a narrow base, but higher than before, and therefore will stand looser, which the farmers desire. But in this case it generally falls on its back before it has been far enough removed, and is then pushed aside, and left with the grassy side down, which is not approved of. On the other hand, when the depth considerably exceeds the breadth, the sods, now turned on their sides, must be squeezed home to the ploughed land, which breaks them and tosses them up, making rough work. In wet clay soil, this is also apt to knead them together. On the whole, it is best to have the breadth and depth nearly equal. But all this is workmanship, and has no dependence on the width of the sole behind.

We have already said that the sole is generally level ^{It should be level.} from right to left at the heel. This was not the case formerly, but the wrest was considerably raised behind. It resulted from this form, that the furrow was always shallower on the right side, or there was left a low ridge of unstirred earth between the furrows. This circumstance alone was a bad practice; for one great aim of ploughing is the renewal of the superficial soil. In this way of ribbing the furrows, the sod tumbles over as soon as it is pushed to the top of the rib on the right of the *rut* made by the plough; the firmest parts of it fall undermost, and the rest crumbles above it, making the work appear neat; whereas it is extremely unequal,

Instruments and what most needs the influence of the weather to
of Husbandry. crumble it down is sheltered from it. Add to these
circumstances, that the hollow is a receptacle for water,
with a surface which can retain it, having been conso-
lidated by the pressure of the plough. For all these rea-
sons, therefore, it seems advisable to form the furrow
with a flat or level bottom, and therefore to keep the
heel of the wrest as low as the heel of the head. For
the same reason it is proper to hold the plough with the
land side perpendicular, and not to heel it over to that
side, as is frequently done, producing the same ribbed
furrow as an ill formed sole.

Length of the plough. There is great variety of opinions about the length
of the plough. If considered merely as a pointed instru-
ment, or even as a cutting instrument acting obliquely
on a given length of sod, there can be no doubt but
that it will be more powerful as it is longer: that is, it
will require less force to pull it through the ground.
But it must also shove the earth aside, and if we double
its length we cause it to act on twice as much earth at
once; for when the plough has entered as far as the
heel, the whole furrow side is acting together in push-
ing the earth to the side. Now it is found, that the
force necessary for pushing a mass of earth horizontally
along the rough ground is nearly equal to its weight.
It would seem, therefore, that nothing is to be gained
by making the base of the plough of a great length, ex-
cept a greater facility in making the first penetration,
and this is chiefly performed by the coulter and stock;
and a great length renders the plough heavy and cum-
bersome, and, by causing it to act long on the sod,
tends to knead and cake it.

Nothing very precise can be offered on this subject.
Some

Some sensible advantage is derived by making the Instruments of Husbandry. plough taper, especially forward, where it acts as a boring and cutting instrument ; and for this purpose it is convenient to give the coulter a slope of 45 degrees. (This has also the advantage of throwing up the stones and roots, which it would otherwise drive before it feather. through the firm ground.) And for the same reason the edge of the feather has a great slope, it being 10 inches long and only six inches broad. But if we pursue this advantage too far, we expose ourselves to another risk. It is sometimes necessary to heel over the plough to the right in order to get over some obstruction. In doing this, the coulter is necessarily raised for a moment, and the slanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long slope, this groove has force enough to guide the whole plough ; and it is almost impossible for the ploughman to prevent it from running out of the ground to the land side *. The feather, therefore, should not exceed ten or twelve inches in length.

But to return to the length of the plough, from which this observation has diverted us a little, we must add, that a long plough has a great advantage in the steadiness of its motion, having a much more extensive support both on the land side and below, and being therefore less affected by its inequalities. Accordingly they are now made considerably longer than formerly ; and

* This is often felt with the excellent plough described by Mr Arbuthnot of Surry, in the Transactions of the Society for the Encouragement of Arts, &c. London.

Instruments 33 inches has been assumed as a proportion to 9 inches of Husbandry dry, of breadth, in conformity to the most approved ploughs now in use.

The mould-board. We come now to treat of the mouldboard. This is the most delicate part of the plough, and is to be seen in the greatest variety in the works of different artists, each of whom has a nostrum of great value in his own opinion. It is here indeed that the chief resistances are exerted and must be overcome; and a judicious form of this part of the plough may diminish them considerably, while it performs the work in the best manner. Without pretending to say that the different resistances are susceptible of an accurate determination, we can still draw sufficient information from palpable rules of mechanics to direct us to what would be nearly the best possible form for a mouldboard. The task to be performed is to raise, push aside, and turn over to a certain degree, a slice already cut off from the firm ground. As we cannot provide for every inequality of the cohesion or tenacity of the earth, our safest way is to consider it as uniform: the weight of it is always so. As we cannot provide for every proportion between the tenacity and the weight, we must take an average or medium proportion which is not far from that of equality. Conceiving the slice at first as only tenacious, and without weight, it is an easy problem to determine the form which shall give it the intended twist and removal with the smallest force. In like manner we can proceed with a slice that has weight without tenacity. It is equally easy to combine both in any proportion; and it is easiest of all to make this combination on the supposition of equality of weight and cohesion. Supposing the slice like a brick, we know that it requires the greatest force

to

to begin to raise it on one edge, and that the strain becomes less as it rises, till its centre of gravity is perpendicularly above the supporting angle. It requires no force to raise it further ; for on pushing it beyond this position, it would fall over of itself, unless withheld by the tenacity of what is not yet raised. But on considering the form or plan of the sodd, we find that while the weight of the sod resists most strongly, there is less of it in this situation actually rising, and this nearly in the same proportion with the labour of raising it ; and we see that after the sod has attained that position in which it is ready to fall over, it has reached the wider part of the wrest, and is now pushed aside, which requires nearly the same force as to raise it : and this continues to the end of the operation.

When we take all these circumstances into consideration, it appears probable, that the compound resistance does not change much from first to last. If this be really the case, it is an undoubted maxim that the whole operation should proceed equably : if it does not, there must be some part of the sod that makes a resistance greater than the medium ; and as the resistances in all this class of motions increase nearly as the squares of the velocities with which they are overcome, it is demonstrable that we shall lose power if we render them unequal.

Hence we deduce this maxim, *That as the plough advances through equal spaces, the twist and the lateral sliding of the sod should increase by equal degrees.* And this determines *a priori* the form of the mouldboard. This principle occurred to Mr James Small, a plough-maker in Berwickshire, and he published a treatise on the subject in 1784. He has given several methods for constructing

How to be formed.

Instruments of Husbandry constructing mouldboards, which he supposes are in conformity to his principle; but being merely a country artist, and unacquainted with science, his rules do not produce mouldboards having this property of equable operation, although they do not deviate far from it. His book is a very useful and instructive performance, and level to the capacity of those for whom it is intended; and we have here availed ourselves of the author's information on many points.

The high character which Small's ploughs have maintained for 28 years is a strong argument for the truth of the maxim. We shall, therefore, give such instructions as will enable any intelligent workman to construct such a mouldboard without any risk of failure; and if future theory or experience should discover any error in the principles from which this maxim is deduced, by showing that either the weight, the tenacity, or the lateral resistance, is exerted according to a different law from what has been assumed, the directions to be given are of such a nature that they adapt themselves with precision to these changes of principle, and will still produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; because at present the instrument is constructed very much at random, and by a guess of the eye.

Plate XI. Let us now return to the wedge formerly made use of for illustrating the action of the plough. Suppose it placed in a furrow already ploughed, and that the space before the line FE (fig. 1.), which is square from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raise the cloth,

cloth, which will now cover the side of the wedge, forming the triangle f DE. The line f D is what formerly lay in the angle along the line FD, and f E formerly lay on FE. It is this line FE, therefore, that we are to raise, shove aside, and twist round, by equal degrees, while the plough advances through equal spaces.

Now, if the length DF of the plough-wedge, reckoned from the point of the stock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DEf will be nearly 74° . The construction of the furrow side of the plough is therefore reduced to this very simple problem, "To make the angle DEf turn equably round the axis DE, while the angular point L advances equably from D to E."

This will be done by means of the following very simple tool or instrument. Let IHFK (fig. 7.) be a piece of hard wood, such as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the same breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We shall call this the *stock* of the instrument. Let ABC be a piece of clean oak half an inch thick, 20 inches long, and 3 inches broad at the end BC. Let this be fashioned like the style of a sundial, having its angle ABC 74° . Let it have a part BCE square, to the extent of 4 inches from C, and the rest EA worked into the form of a straight slender rod. Let EFG be a semicircle of clean plane tree, or of metal, 4 inches radius: fasten this by small screws to the square part of the style CE, so that its centre may be at C. Let this semicircle be divided into 180 degrees, and numbered from G along the arch GFE, so that

Instruments that 0° may be at G, and 180° at E. Let this style of Hubban-dry. and semicircle turn round the line BC by means of small hinges. This instrument may be called the mouldboard gage, or protractor. When the stile is folded down on the stock BIK, the point G will be at F; and, when it is raised up to any angle, the degrees will be pointed out on the semicircle by the straight edge CF.

Nothing can be more obvious than the manner of employing this instrument, once we have determined the most proper position for the sod when the work is completed. Now it seems to be the opinion of the most intelligent farmers, that the best position of the sod is that represented in fig. 1. Plate XII.

Proper po-
sition of
the sod.
Plate XII. Fig. 1. represents a section of the ground and the working parts of the plough, as viewed by a person standing straight before it. ABDC is the unploughed ground, and WB the coulter, kneed in Small's manner. FGKB is the section of the plough (or rather of the whole space through which the plough has passed, for no part of the plough has this section). HOFE is the section of a slice, pushed aside and turned over, so as to lean on the next. HE is that side of the slice which formerly lay on KB. EF is the side cut off by the coulter; and FO is the upper or grassy side. The lower corners are supposed to be a little bruised inwards, as must generally happen.

The sod is pushed 9 inches to the right hand, and it leans with its grassy side on the preceding furrow, in an angle of about 50 degrees. In this position the grass is turned down so as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the

the weather : and if the harrow is dragged across these ^{Instruments} _{of Huban-} ridges, it distributes along the surface the mould which _{dry.} was formerly at the bottom. The sod has got a twist ^{of} _{Plate XII.} of 130 degrees : but it is evident, that after it has been turned 90 degrees, or even a little before this, it is ready to fall over of itself. It is sufficient, therefore, that it be turned 90 degrees when the heel of the wrest has reached it, and the remainder of the twist is given to it by the wing or flap of the mouldboard. This, then, dictates to us the manner of applying the instrument.

. Divide the edge DE (fig. 2.) of the wrest, or of a lath nailed on it, into 90 equal parts, and continue the divisions backwards to G in the same line to 130. Number the divisions backwards from the point of the stock ; then place the protractor on the edge of the wrest with the point B of fig. 7. Plate XI. at the 90th division (fig. 2. Plate XII.); that is, just at the heel, with the stock under the wrest, and the stile raised to 90° , and press it home to the joint, so that the stock may be square to the edge, and then the style will be in the position suiting that part of the mouldboard. In like manner slide the stock forwards ^{How to} to the 80th division, and lower the style to 80° , and it ^{form the} _{mould-} will have the position which suits that part of the mould-board. In the same way slide it forward to 70, 60, 50, &c. and lower the style to 70° , 60° , 50° , &c. and we shall have the position for these several parts of the mouldboard ; and thus it may be formed to the very point of the stock, because the straight edge of the wrest ^{may be continued so far.} A block of wood may be hewed to fit these several positions of the protractor ^{style} ; and thus, when placed with its straight edge on ^{the} outer line of the wrest, and cut away behind in the land-

Instruments land-side plane, will be the exact shape of the plough-
of Hulban-
dry. wedge. It would rise up indeed into a tall piece of
singular shape, gradually tapering down to the point of
the stock ; but when cut off parallel to the ground, at
the height of about 12 inches, it will form the mould-
board, the front or edge of the sheath, and the whole
back of the stock except the feather, which is an extra-

Plate XII. neous piece. The wing or flap of the mouldboard is
formed in the same manner, by sliding the stock of the
protractor to 100, 110, 120, 130, and opening the
stile to 100° , 110° , 120° , 130° . This will extend the
top of the mouldboard to about 22 or 23 inches ; but
the lower part of the wing must be cut away, because
it would push the sod too far aside after it has got the
proper twist. The form of this part should be such as
would exactly apply itself to a plank set at the heel of
the wrost, parallel to the land side of the head, and lean-
ing outward 40 degrees. This will be very nearly the
case, if it be made a sweep similar to the edge of the
sheath. Fig. 3. is a resemblance of the surface of the
mouldboard : AD being the edge of the sheath, E the
heel of the wrost, and EBC the wing or flap. When
cut through in a perpendicular direction, the section is
hollow ; if cut horizontally it is convex ; and if in the
direction CE, making an angle of 74° with ED, it is
straight. If the protractor be set on it at D, and gradu-
ally slid back, the mouldboard will gradu-
ally open the stile, and the stile will skim its whole sur-
face without any vacuity between them.

This form is given to the mouldboard on the autho-
rity of the supposition that the sum of the resistances
arising from weight and tenacity remains pretty con-
stant in its whole length. This cannot be affirmed with

confidence in any case, and is by no means true in all. Instruments of Husbandry. In stiff clay soils the effects of tenacity prevail, and in light or crumbling soils the weight is the chief resistance. The advantage of this mode of construction is, that it can be adapted to any soil. If the difficulty of cutting and raising the sod is much greater than that of shoving it aside and turning it over, we have only to make the rise and twist more gentle towards the point Plate XII. of the stock, and more rapid as we advance; and it is easy to do this according to any law of acceleration that we please. Thus, instead of dividing the edge of the wreathe DE (fig. 4.) continued to G into 130 parts, draw a line Gg perpendicular to it, and draw some curve line Dg convex towards DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wreathe edge, cutting it in 10, 20, 30, 40, &c. and apply the protractor to these points. It is evident that the divisions of the wreathe-line are bigger at D, and grow gradually less towards G; and therefore, because each has 10° more twist than the preceding, the twist will be more rapid as it approaches the end of the mouldboard. This curve may be chosen so as to produce any law of acceleration. On the contrary, we produce a retarded or diminished twist by making the curve concave towards DG, as represented by the dotted curve.

The mathematical reader will observe, that this construction aims at regulating the twist round the line of the wreathe ED. This does not produce precisely the same regulation round the line FD, which is the line of the plough's motion, and of the sod's position before it is ploughed over. The difference, however, is not worth attending to in a matter so little susceptible of precision.

*Instruments
of Husbandry.*

Instead of placing the stock of the protractor square with the edge of the wrest, it may be placed square with the land side of the plough. To do this, draw a line BL (fig. 8.) across the stock from the point B, making the angle LBC 16° , and put a brass pin at L, making a hole in the style that it may not be prevented from folding down. Then, in using the instrument, let the points B and L rest against the edge of the wrest, and proceed as directed.

Plate XI.

A still greater variety of forms, and accommodation to particular views, with the same general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the style, so as to form a style of a variable angle.

A tool may even be constructed in which the rod BA might be a cutting knife: and the whole may be led along by a screw, while this knife turns round according to any law, and would gradually pare away the mouldboard to the proper form.

Thus have we reduced the fashioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mouldboard made according to the maxim now given will make the best possible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No description of any curve mouldboard to be met with in books has this advantage; and we say that this rule is capable of any systematic variation, either with respect to the width of furrow, or the quantity or variation of its twist. We have

have therefore put it in the power of any intelligent person to make such gradual and progressive changes as may serve to bring this most useful of all instruments to perfection. The angle of the head and wrest, and the curve for dividing the wrest-line, can always be expressed in writing, and the improvements communicated to the public at large.

After this description of the working parts of a plough, and directions for giving it the most effective form, it will not be improper to consider a little its mode of action, with the view of attaining a more distinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure.

Returning again to the wedge (fig. 1.), we see that it is pressed down at the point D, and as far back along the mouldboard as its surface continues to look upward, that is, all the way to the heel of the wrest. Behind this, the perpendicular sections of the mouldboard overhang, and look downward; and here, while pressing down the sod, the plough is pressed upwards. These two pressures tend to twist the plough round a transverse line somewhere between the heel and the point. The plough therefore tends to rise at the heel, and to run its point deeper into the ground. Upon the whole, the pressure downwards is much greater than the upward pressure. It is exerted over a much greater space, and is greater in most parts of that space. Behind, very little downward pressure is necessary, the sod being ready to fall down of itself, and only requiring a gentle touch to lay it in a proper position.

In like manner the plough is pressed backward by the resistance made to the coulter and stock, and part of the resistance made to the sloping side of the mouldboard:

~~Instruments~~ and it is pressed to the left by the other part of the press
~~as H than~~ ^{dry,} sure on the sock and mouldboard.

All these pressures must be balanced by the joint action of the cattle, the resistance of the bottom, and the resistance of the firm ground on the left hand or land side.

It is the action of the cattle, exerted on that point to which they are attached, which produces all these pressures. It is demonstrated by the principles of mechanics, that this force must not only be equal to the mass or compound force of these resisting pressures, but must also be in the opposite direction,

It is further demonstrated, that if a body be dragged through any resisting substance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the resistances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the resistances on one side of this point are in equilibrio with those on the opposite side.

And, lastly, it is demonstrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the sock.

When therefore a plough advances steadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 5.) be produced backwards to the point G of the mouldboard, that point is the place round which all the resistances balance each other. This

This point may be called the *centre of resistance* and the *Instruments of Husbandry.*

It would be of importance to determine this point by principle ; but this can hardly be done with precision even in a plough of a known form : and it is impossible to do it in general for all ploughs, because it is different in each. It even varies in any plough by every variation of the proportion between the weight and the cohesion of the sod. We see how it can be found experimentally in any given uniform sod, viz. by producing backwards the line of draught. Then, if the draught rope, instead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the same direction, the plough would continue to perform its work without any assistance from the ploughman, while the sod continued uniform. But the smallest inequality of sod would derange the plough so as to make it go entirely out of its path. Should the resistances between G and D prevail, the plough would go deeper, which would increase the resistances on that side where they already exceed, and the plough would run still deeper. Should the resistances behind G prevail, the heel would be pressed down, and the point would rise, which would still farther destroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For these reasons we must not think of attaching the draught to the centre of resistance ; but must contrive a point of draught, such as shall restore the plough to its proper position when it has been driven out of it by any obstruction.

The muzzle or end of the beam is a point which will Muzzle of
completely the beam.
Q 2

Instruments of Husbandry. completely suit our purpose. For suppose that the resistance on the back of the stock has prevailed, and the plough MNFD (fig. 5.) has taken the position *m n f d* represented by the dotted lines, the draught line GMO is brought down into the position *g m o*, diverging a little from GMO, and meeting the mouldboard in a point *g* considerably before G. By this means the resistances on the hinder side of *g* are increased, and those before it are diminished, and the plough quickly regains its former position.

The point of draught.

From these observations it is plain, that whatever is the situation of the centre of resistance, the point of draught may be so chosen that the action of the cattle shall be directly opposed to the resistance of the ground, and that moreover the plough shall have no tendency either to go deeper or to run out. This is the use of the apparatus at the point of the beam called the muzzle, represented at H (fig. 4.) It turns round a bolt *i* through the beam, and can be stopped at any height by another pin *k* put through the holes in the arch *l m*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught rope is hooked is spread out horizontally, as shown by HK, and has several notches O in it, to either of which the hook can be applied. This serves to counteract any occasional tendency which the plough may have to the right or left.

When the plough goes on steadily, without any effort of the ploughman, it is said to be in trim, and to swim fair; the pressure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught rope as high as possible.

In

In this state the plough should have a continual tendency to rise at the heel, and even to run a little into the ground. Then hook the rope as low as possible. The plough should now press hard on the furrow with the heel, and have some tendency to run out of the ground. If both these are observed, the plough is properly constructed in this respect; if not, it must be altered, either by changing the position of the sock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raising the point of the sock will also have the same effect. But it is of considerable importance not to take the point of the sock out of the plane of the sod, and it is much better to make the alteration by the beam. The slope of the coulter has a considerable effect, but it cannot be placed very far from the inclination of 45° without the risk of choking the plough by driving the roots and stones before it. It is of great consequence to have the coulter fit exactly in the direction of the plough's motion; if it is in any other direction, it will powerfully twist the plough into its own track. As it must be fixed in the middle of the beam's thickness to have strength, it is removed a little from the plane of the land side, and it was the usual practice to point it to the left below to compensate for this; but this by no means removes the disposition to twist, and it exposes to the risk of catching a stone between its point and that of the sock, which must now be driven forward through the firm ground at a great expence of labour to the cattle. Mr Small has very ingeniously remedied this, by giving the coulter a short knee to the left immediately below the beam, and thus point-

Instruments ing it downwards in the plumb of the land side. See of Huban-dry. fig. 1. Plate XII.

It is not without its use to know the absolute force necessary for tilling the ground. This has been frequently measured with a spring steelyard. One of Small's ploughs worked by two horses, and employed in breaking up stiff land which had been ploughed before winter, and much consolidated by the rains, required a force of 360lbs. avoirdupois; and we may state this as the ordinary rate of such work; but moderately firm sod, under good culture, requires at a medium 320lbs.

As we wish to embrace every opportunity of rendering this work useful to the public, we shall conclude this article with an account of a plough which has been recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell minister of Kilcalmonill in Argyleshire, was honoured with the Society's gold medal, value 25l.

Plate XII.
The Ar-gyleshire
plough.

A, the sock (fig. 6.); the land side of which supplies the place of the coulter, and the sole of it serves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finished, and somewhat under half an inch thick.—B, the head; to be made of iron in a triangular form, 4 inches broad by 2 inches at the thickest part. There are 5 inches of the head fixed in the sock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the sheath, must be of the same thickness with the beam above and the head below, and is 5 inches broad. An iron screw-bolt connects the beam and head behind the sheath.—F, the handles are so made

made that the slope of the mouldboard, which is fixed Instruments
to one of them, may be the longer and more gradual. of Husbandry.
They are 5 feet 8 inches long, and 2 feet 4 inches asunder at the ends.—G, the mouldboard, consists of 7 rounded sticks 2 inches in diameter; the covert of them is in the plane of the sole, the rest in succession close to each other above it. This makes the mouldboard 14 inches broad. To prevent any earth from getting over the mouldboard, a thin deal 4 or 5 inches broad is fixed above it. The mouldboard, land-side, and sole of the plough, are clad with iron.—The length is 20 inches: this added to 18 inches, the length of the stock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is also of a more convenient and better construction than those commonly in use. By means of the screw pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved sidewise in the socket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a screwbolt at H. Two inches of the rod project at N, in the form of an eye, before the muzzle, to receive the hook of the crostree.

The advantages of this plough are said to be: It is not so liable to be interrupted or turned out of its course by stones, roots, &c. as other ploughs are; nor does it dip so deep as to be liable to be broken by large stones or flags. The motion of the muzzle is also thought an improvement. Another advantage it has over other ploughs is, its not being so liable to be choked up by stubble, &c. This we understand to be its chief excellency, and an object much desired in the construction of the plough. Upon the whole, we are informed,

Instruments that this plough is lighter, less expensive, and less liable of Husbandry. to go out of trim, than the ordinary plough, and that with it two horses can plough land which requires four with any other plough.

Objections to its construction. Such are said to be the advantages of this construction; but we cannot help expressing our apprehension, that the uniting the coulter and feather at the point of the stock will expose the plough to great risks of being put out of order. When the upright edge strikes a stone obliquely, especially on the land side, it must be violently twisted round the point of the head; and, having but a moderate thickness at this part, may be broken or permanently twisted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the stock and putting it in the fire. When a coulter is bent by the same cause, the ploughman can either rectify it by altering the wedging, or he can straighten it in the field; and it must be observed, that the plough opposes much less resistance to the derangement of this sort of coulter than of the common one. In the common coulter the strain does not so much tend to twist the plough round the line of its motion, as to press it wholly to landward. The resistance to this is great; but a very moderate force will twist it round its line of motion. In either case, if the blow be given in that point of the coulter where the draught line crosses it, there will be no twist of the whole plough, but the point of the plough will be forced horizontally to or from the land. When the blow is out of this line, the strain tends to twist the beam or the plough. Experience will determine which of the two is the most hazardous.

hazardous. Models of these ploughs are to be seen in ^{Instruments of Husbandry.} the hall of the Highland Society.

The plough constructed in the following manner is ^{Scots} still the most common and the most generally understood ^{Scots} plough. in Scotland; and, if properly made, is the best for answering all purposes, when only one is used; though others are, perhaps, more proper on some particular occasions.

The parts of which this plough is composed, are, ^{Description of the Scots plough.} the head, the beam, the sheath, the wrest, the mould-board, the two handles, the two rungs, the flock, and the coulter; the two last are made of iron, and all the rest of wood.

The HEAD is designed for opening the ground below. ^{Plate I.} The length of the head from A to B is about 20 inches, ^{fig. 1.} and the breadth from A to D above five inches; C is the point upon which the flock is driven, and the length from B to C is about six inches; a is the mortise into which the larger handle is fixed, and b is the mortise into which the sheath is fixed.

The head is that part of the plough which goes in the ground; therefore the shorter and narrower it is, the friction will be the less, and the plough more easily drawn; but the longer the head is, the plough goes more steadily, and is not so easily put out of its direction by any obstructions that occur. Twenty inches is considered as a mean length; and five inches as the most convenient breadth.

The SHEATH E is driven into the mortise B, and ^{Fig. 2.} thus fixed to the head A B. It is not perpendicular to the head, but placed obliquely, so as to make the angle formed by the lines AB and EB about 60 degrees. The sheath is about 13 inches long, besides what is driven into

^{of Huban-}
Instruments into the mortise *b* (fig. 1.); about three inches broad,
^{dry.} and one inch thick.

The sheath is fixed to the mouldboard, as in Plate II.
fig. 5. E, in the same manner as the wrest is fixed to
the head in Plate I. fig. 4.

The MOULDBOARD is designed to turn over the
earth of the furrow made by the plough; and it is ob-
vious, that, according to the position of the sheath, the
mouldboard will turn over the earth of the furrow more
or less suddenly. Besides, when it forms a less angle
with the head than 60 degrees, the plough is in great
danger of being *cocked*, as the farmers term it.

Plate L
Fig. 3.

The larger HANDLE, FA, is fixed to the head, by
driving it into the mortise *a* (fig. 1.) It is placed in
the same plane with the head; and its length from
AF is about five feet four inches, and its diameter at
the place where it is fixed to the beam is about two
inches and a half, and tapers a little to the top F.
About ten inches from A, there is a curve in the
handle, which, when F is raised to its proper height,
makes the lower part of it nearly parallel to the sheath EB.
This curve is designed to strengthen the handle.
The proper position to the handle is, when the top F is
about three feet two inches higher than the bottom of
the head AB.

The longer the handles, the plough is the more easily
managed, because the levers are more distant from the
centre of motion. The higher the top of the handles,
the plough is the more easily raised out of the ground,
provided they be no higher than the lower part of a
man's breast.

Fig. 6.

The BEAM is fixed to the larger handle and the
sheath, all of which are placed in the same plane with
the

the head. The length of it, from H to I, is about six feet; its diameter is about four inches. When the plough is in the ground, the beam should be just high enough not to be incommoded by any thing on the surface.

The position of the beam depends on the number of cattle in the plough. When two horses are yoked, the beam should be placed in such a manner as to make the perpendicular distance betwixt the bolt-hole of the beam and the plane of the head about 21 inches; when four horses are yoked, two a-breast, this distance should only be about 18 inches.

The **SOCK**, BP, is fixed to the end of the head, Plate L Fig. 3. and is about two feet long. In fitting the sock to the head, the point ought to be turned a little to the land or left side; because otherwise it is apt to come out of the land altogether. When turned to the left, it likewise takes off more land; when turned upwards, the plough goes shallow; and when downwards, it goes deeper.

The **COULTER** is fixed to the beam, and is about two feet ten inches long, two inches and a half broad, sharp at the point and before, and thick on the back, like a knife. It is fixed and directed by wedges, so as to make the point of it equal to, or rather a little before, the point of the sock, and upon a line with the left side of the head. This oblique position enables it to throw roots, &c. out of the land, which requires less force than cutting or pushing them forward.

The **WREST**, BD, is fixed to the head, and is about 25 inches long, two broad, and one thick. It is fixed to the head at B, in such a manner as to make the angle contained between the lines AB and BD about 25 degrees.

~~Instruments~~ grees. The wrest is seldom or never placed in the same plane with the head, but gradually raised from the place where it is fixed to it; that is, from B to K, as in fig. 7. The position of the wrest determines the nature of the furrow. When the wrest is wide and low set, the furrow is wide; and when it is narrow and high set, the furrow is narrow.

Plate II. Fig. 1. represents the two HANDES, fixed together by the two rungs. The larger handle has already been described; the lesser one is a few inches shorter, and does not require to be quite so strong. The distance of the handles at the little rung depends on the position of the wrest. Their distance at M and P is about two feet six inches. The lesser handle is fixed to the mouldboard at M, fig. 4. and to the wrest KB, at L.

Fig. 5. represents the plough complete, by joining together fig. 8. Plate I. and fig. 4. Plate II. in the sheath EB. The wrest BK is supposed to make an angle with the head AB as in Plate I. fig. 4. and the handles joined together as in Plate II. fig. 1.

After having given such a particular description of all the parts and proportions of the Scots plough, it will easily appear how it separates, raises, and turns over the earth of the furrow. If it had no coulter, the earth would open above the middle of the stock, and in a line before the sheath; but as the coulter opens the earth in a line with the left side of the head, if the soil has any cohesion, the earth of the furrow will be wholly raised from the left side, and, as the stock moves forward, will be thrown on the right side of the sheath, and by the casting out of the mouldboard, or the raising of the wrest, will be turned over.

The BRIDLE, OR MUZZLE, is another article belonging

ing to the plough. It is fixed to the end of the beam, <sup>Instruments
of Husbandry.</sup> and the cattle are yoked by it. The muzzle commonly used is a curved piece of iron, fixed to the beam by a bolt through it. ABC is the muzzle, AC the bolt by which it is fixed to the beam ; D is the swingle-tree or cross-tree, to which the traces are fixed ; and B is a hook, or *cleek*, as it is commonly called, which joins the muzzle and swingle-tree.

Some use another kind of muzzle, ABCD. It is fixed to the beam by two bolts, and has notches by which the cleek of the swingle-tree may be fixed either to the right or the left of the beam. There are also different holes for the hind bolt to pass through, by which the draught may be fixed either above or below the beam. AD is the fore bolt upon which the muzzle turns ; on BC are four notches, betwixt any two of which the cleek of the swingle-tree may be fixed. When the cleek is fixed at B, the plough is turned towards the firm land, and takes off a broader furrow ; and when fixed at C, it is turned towards the ploughed land, and takes off a narrower furrow. E and F are the holes on each side through which the hindmost bolt passes. When the bolt is put through the highest two, these holes being thereby brought to the middle of the beam, the fore part of the muzzle is raised above the beam, and the plough is made to go deeper ; and when put through the lowest two, the fore part of the muzzle is sunk below the beam, and the plough is made to go shallower. This muzzle may be so constructed as to have the same play with the common one. A is the end of the beam ; B a plate of iron sunk into it, and, with a similar one in the other side, is rivetted into it by bolts ; C is the muzzle fixed to these plates

Fig. 16.

of

~~Instruments~~ of iron by a bolt, which bolt may be put through any of the holes marked on the plate B. From the construction of this muzzle it is plain, that it has the same play with the common one, and that by it the land of the plough may be altered at pleasure.

~~Properties of the Scots plough.~~ Of all forms, that of the Scots plough is the fittest for breaking up stiff and rough land, especially where stones abound ; and no less fit for strong clays hardened by drought. The length of its head gives it a firm hold of the ground ; its weight prevents it from being thrown out by stones ; the length of the handles gives the ploughman great command to direct its motion ; and by the length of its head, and of its mouldboard, it lays the furrow-slice cleverly over. This plough was contrived during the infancy of agriculture, and was well contrived : in the soils above described it has not an equal.

~~In what soil improper.~~ But in tender soil it is improper, because it adds greatly to the expence of ploughing, without any counterbalancing benefit. The length of the head and mouldboard increases the friction, and consequently it requires a greater number of oxen or horses than are necessary in a shorter plough. There is another particular in its form that resists the draught : the mouldboard makes an angle with the stock, instead of making a line with it gently curving backward. There is an objection against it no less solid, that it does not stir the ground perfectly : the hinder part of the wrost rises a foot above the sole of the head : and the earth that lies immediately below that hinder part, is left unturned. This is ribbing land below the surface, similar to what is done by ignorant farmers on the surface.

These defects must be submitted to in a soil that requires

quires a strong heavy plough; but may be avoided in a cultivated soil by a plough differently constructed. Of all the ploughs fitted for a cultivated soil free of stones, that already mentioned, which was introduced into Scotland about 20 years ago, by James Small in Blackadder mount, Berwickshire, is the best. It is now in great request; and with reason, as it avoids all the defects of the Scots plough. The shortness of its head and of its mouldboard lessen the friction greatly: from the point of the flock to the back part of the head it is only 30 inches; and the whole length, from the point of the beam to the end of the handles, between eight and nine feet. The flock and mouldboard make one line gently curving; and consequently gather no earth. Instead of a wrest, the under edge of the mouldboard is one plane with the sole of the head; which makes a wide furrow, without leaving any part unstirred. It is of late commonly termed the *chain-plough*, because it is drawn by an iron chain fixed to the back part of the beam immediately before the coulter. This has two advantages: first, by means of a muzzle, it makes the plough go deep or shallow; and, next, it stresses the beam less than if fixed to the point, and therefore a slenderer beam is sufficient.

As we have already sufficiently explained the speculative principles upon which this plough is formed, we shall only remark, that it is proper for loams, for carse clays, and, in general, for every sort of tender soil free of stones. It is even proper for opening up pasture ground, where the soil has been formerly well cultivated.

A spiked flock is used in the Scots plough. The difference between it and the feathered flock will be best

Instruments best understood by comparing their figures. Fig. 7. *of Husbandry.* is the common flock, and fig. 3. the feathered one.

From the construction of the feathered flock, it is obvious, that it must meet with greater resistance than the common flock. However, when the plough takes off the earth of the furrow broader than that part of the flock which goes upon the head, it is more easily drawn than the plough with the common flock; for the earth which the common flock leaves to be opened by the wreft, is more easily opened by the feather of the other flock. In ley, the feathered flock makes the plough go more easily, because the roots of the grass, which go beyond the reach of the plough, are more easily cut by the feather than they can be torn asunder by the common flock. The feathered flock is also of great use in cutting and destroying root weeds. The common flock, however, answers much better in strong land.

It is proper here to add, that in fitting the feathered flock to the head, the point of it should be turned a little from the land, or a little to the right hand.

A chain-plough of a smaller size than ordinary, drawn by a single horse, is of all the most proper for horse-hoeing, supposing the land to be mellow, which it ought to be for that operation. It is sufficient for making furrows to receive the dung, for ploughing the drills after dunging, and for hoeing the crop.

A small single-horse plough is recommended for various purposes. A still smaller plough of the same kind may be recommended for a kitchen garden. It can be reduced to the smallest size, by being made of iron; and when the land is properly dressed for a kitchen garden, an iron plough of the smallest size drawn by a horse will save

save much spade-work. In Scotland, forty years ago, a kitchen garden was an article of luxury merely, because at that time there could be no cheaper food than oatmeal. At present, the farmer that maintains his own servants does so at double expence, as the price of oatmeal is doubled ; and yet he has no notion of a kitchen garden more than he had thirty years ago. He never thinks, that living partly on cabbage, kail, turnip, carrot, would save much oatmeal ; nor does he ever think, that change of food is more wholesome, than vegetables alone, or oatmeal alone. We need not recommend potatoes, which in scanty crops of corn have proved a great blessing : without them, the labouring poor would frequently have been reduced to a starving condition. Would the farmer but cultivate his kitchen garden with as much industry as he bestows on his potato crop, he needed never fear want ; and he can cultivate it with the iron plough at a very small expence. It may be held by a boy of 12 or 13 ; and would be a proper education for a ploughman. But it is the landlord who ought to give a beginning to the improvement. A very small expence would enclose an acre for a kitchen garden to each of his tenants ; and it would excite their industry, to bestow an iron plough on those who do best.

Nor is this the only case where a single horse plough may be profitably employed. It is sufficient for seed-furrowing barley, where the land is light and well-dressed. It may be used in the second or third ploughing of fallow, to encourage annual weeds, which are destroyed in subsequent ploughings.

The *Rotheram plough* is a machine of very simple construction, and easily worked. AB is the beam, CD the sheath, EBD the main handle, FR the smaller handle,

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R

Plough,
Plate V.
fig. 3.

Instruments handle, GH the coulter, KI the flock or share, NP the
 of ^{the}
^{dry.} bridle, S the fly-band, and ML a piece of wood in place
 of a head. The whole of this plough should be made
 of ash or elm; the irons should be steeled and well
 tempered; and that part of the plough which is under
 ground in tilling should be covered with plates of iron.
 The difference between this and the common plough
 seems to consist in the bridle at the end of the beam,
 by which the ploughman can give the plough more or
 less land by notches at N, or make it cut deeper or
 shallower by the holes at P; in the coulter or share,
 which are so made and set as to cut off the new furrow
 without tearing; and in the mouldboard, which is so
 shaped as at first to raise a little, and then gradually turn
 over, the new cut furrow, with very little resistance.
 But the greatest advantage attending it, is its being so
 easy of draught, that it will do double the work of any
 common plough.

The Paring Plough,
 Plate V.
 fig. 4. The *paring plough* is an instrument used in several
 parts of England for paring off the surface of the
 ground, in order to its being burnt. Mr Bradley has
 given the following very perspicuous description of
 this instrument: From A to A is the plough-beam,
 about seven feet long, mortised and pinioned into
 the block B, which is of clean timber without knots.
 CC are the sheaths or standards, made flat on the
 inside, to close equally with the paring plate, and
 fastened to it with a bolt and key on each side, as at
 D. E is the paring plate of iron laid with steel, about
 four inches wide, and from 12 to 18 inches long.
 This plate must be made to cut on the sides, which are
 bolted to the standards as well as at the bottom part.
 FF are two iron braces to keep the standards from giving

ing way : these standards must be mortised near their Instruments of Husbandry. outsides and through the block. GG are the plough handles, which must be fixed slopeways between the beam and the standards. The pin holes in the beam, the use of which is to make this plough cut more or less deep, by fixing the wheels nearer to or farther from the paring plate, should not be above two inches asunder.

Fig. 1. represents the four-coulted plough of Mr Tull. Its beam is ten feet four inches long, whereas that of the common plough is but eight. The beam is straight in the common plough, but in this it is straight only from *a* to *b*, and thence arched; so that the line let down perpendicularly from the corner at *a* to the even surface on which the plough stands, would be $11\frac{1}{4}$ inches; and if another line were let down from the turning of the beam at *b* to the same surface, it would be one foot eight inches and a half; and a third line let down to the surface from the bottom of the beam at that part which bears upon the pillow, will show the beam to be two feet ten inches high in that part. At the distance of three feet two inches from the end of the beam *a*, at the plough-tail, the first coulter, or that next the share, is let through; and at 13 inches from this, a second coulter is let through: a third at the same distance from that; and, finally, the fourth at the same distance from the third, that is, 13 inches, and from *a* to *b* is seven feet.

The crookedness of the upper part of the beam of this plough is contrived to avoid the too great length of the three foremost coulters, which would be too much if the beam was straight all the way; and they would be apt to bend and be displaced, unless they

Instruments were very heavy and clumsy. Ash is the best wood to make the beam of, it being sufficiently strong, and yet light. The sheat in this plough is to be seven inches broad. The fixing of the share in this, as well as in the common plough, is the nicest part, and requires the utmost art of the maker; for the well-going of the plough wholly depends upon the placing this. Supposing the axis of the beam, and the left side of the share, to be both horizontal, they must never be set parallel to each other; for if they are, the tail of the share bearing against the trench as much as the point, would cause the point to incline to the right hand, and it would be carried out of the ground into the furrow. If the point of the share should be set so, that its side should make an angle on the right side of the axis of the beam, this inconvenience would be much greater; and if its point should incline much to the left, and make too large an angle on that side with the axis of the beam, the plough would run quite to the left hand; and if the holder, to prevent its running quite out of the ground, turns the upper part of his plough towards the left hand, the pin of the share will rise up, and cut the furrow diagonally, leaving it half unploughed. To avoid this and several other inconveniences, the straight side of the share must make an angle upon the left side of the beam; but that must be so very acute a one, that the tail of the share may only press less against the side of the trench than the point does. This angle is shown by the pricked lines at the bottom of fig. 9. where *ef* is supposed to be the axis of the beam let down to the surface, and *gf* parallel to the left side of the share: and it is the subtense *eg* that determines the inclination which the point of the share must

must have towards the left hand. This subtense, says Instruments
Mr Tull, at the fore-end of an eight-feet beam, should ne-
ver be more than one inch and a half, and whether the
beam be long or short, the subtense must be the same.

The great thing to be taken care of, is the placing
the four coulters; which must be so set, that the four
imaginary places described by their four edges, as the
plough moves forward, may be all parallel to each
other, or very nearly so; for if any one of them should
be very much inclined to, or should recede much from,
either of the other, then they would not enter the
ground together. In order to place them thus, the
beam must be carefully pierced in a proper manner.
The second coulter-hole must be two inches and a half
more on the right hand than the first, the third must
be as much more to the right of the second, and the
fourth the same measure to the right hand of the third;
and this two inches and a half must be carefully mea-
sured from the centre of one hole to the centre of the
other. Each of these holes is a mortise of an inch
and a quarter wide, and three inches and a half long
at the top, and three inches at the bottom. The two
opposite sides of this hole are parallel to the top and
bottom, but the back is oblique, and determines the
obliquity of the standing of the coulter, which is wedg-
ed tight up to the poll. The coulter is two feet eight
inches long before it is worn; the handle takes up six-
teen inches of this length, and is allowed thus long, that
the coulter may be driven down as the point wears away.
As to the wheels, the left-hand wheel is 20 inches dia-
meter, and that on the right hand two feet three inches,
and the distance at which they are set from each other
is two feet $5\frac{1}{4}$ inches.

Instruments
of Husband-
dry.

Patent
Sward-
cutter,
Plates VI.
and IX.

2. *The Patent Sward-cutter.*

The different parts of this instrument are represented by fig. 6. Plate VI. and fig. 1. and 2. Plate IX. AA, &c. a square frame three feet four inches from the fore to the hind part, by four feet three inches, the breadth of the machine within side; the timber (when of fir) four inches square, placed on two wheels BB three feet diameter, a little more or less (the old fore-wheels of a chaise may answer the purpose), to support the hind part of the machine.

CC, &c. are six strong pieces of wood, called *bulls*, three feet long, five inches and a half broad, the thickness six inches at E, and tapering to three inches at F. Into these bulls are fixed the cutting wheels, which are iron, $1\frac{1}{3}$ inches diameter, $\frac{1}{4}$ ths of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of such thickness, as to allow the edges to be well steeled. The wheels are fixed by two bolts going through the bulls, with eyes on one end for the axles of the wheels to run in, and nuts and screws on the other to make them very firm by being sunk in the bulls, to prevent their interfering with the weights LL, &c. resting on them.

GG, &c. are hollow pieces of wood, called *thorles*, each $3\frac{1}{2}$ inches long, which enclose the bolt MM, and keep the bulls CC, &c. at their proper distances, but may be made longer or shorter at pleasure, according as the sward requires to be cut in larger or smaller pieces. They are in two pieces bound together, and jointed by a strap of leather or cord, which allows them to be readily changed when the cutting wheels require to be kept at more or less distance.

The

The iron bolt MM goes through two pieces of wood Instruments of Huban-dry.
or iron PP, seven inches long, clear of the wood, supported by iron stays fixed to the frame, and through all the bulls. It requires to be strong, as the draught of the horses terminates there.

HH, fig. 1. and 2. a cylinder or segment of wood, Plate IX. seven inches diameter, called a *rocking-tree*, which goes across the frame, and moves on the pivots fixed into it, one at each end, supported by an iron bolt or piece of wood mortised into the frame, eight inches high, as appears in fig. 1. and 2. to which six chains or ropes are fixed by hooks, at different distances, as you want your cuts, nine, eight, seven, or six inches from one another, and are joined to the end of each bull in which the cutting wheels run; so that when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls, with their cutting wheels, are raised out of the ground at once, as in N° 3. by which means the machine may be turned, or moved from place to place with great ease, without any danger of straining the wheels.

LLL, &c. fig. 6. Plate VI. and fig. 1. 2. Plate IX. are weights of freestone, 26 inches long and six inches broad; the under one four inches thick, the upper one three inches thick; weighing about 64lb. the under, and 48 the upper, each of them having two holes, through which iron spikes, firmly fixed in the bulls, pass, in order to keep them steady.

When the ground is easily cut, the under stone may answer; when more difficult, the other stone may be added; so that every wheel may have seven stone weight upon it, which has been found sufficient for the stiffest land and toughest sward the machine has ever

Instruments been tried on. Cast iron weights will answer fully better, but are more expensive.

Plate IX. The lever I, fig. 1. 2. which ought to be five feet long, must have a sliding rope on it; fixed to the back part of the frame; so that when the cutting wheels are all taken out of the ground three or four inches, by the rocking tree's being turned partly round by the lever, the rope may be fixed to it by a loop over the pin R, fig. 2. (it ought to be placed three feet four inches from the extremity of the lever I.) Thus all the cutting wheels are kept out of the ground till the machine is turned; and then by moving the loop off the pin, it slips back towards the frame, and the lever is gently let back to its place, as in fig. 1. by which the cutting wheels are put into their former posture, by the weights fixed on the bulls in which they run. The levers may be made of good tough ash.

Plate VI. PP, fig. 6. a small bolt of iron, with a hook on one end of it (one is sufficient), to strengthen the bolt MM to be hooked on the centre of it, and joined to the frame by a nut and screw.

The grooves in which the cutting wheels run, may be covered below at the hinder part with a plate of thin black iron, 6 inches long, 3 inches broad, having a slit in it where the wheels run, to prevent (if found necessary) any grafts, weeds, or small stones, from filling the grooves, and clogging the wheels.

To the frame fig. 6. are fixed (for a double-horse sward-cutter) three shafts, as in a waggon, of such length, strength, and distance from one another, as any workman many think proper.

For a single-horse sward-cutter (which has only four cutting wheels), a pair of shafts are used, and may

make the two fides of the frame without any joinings. Instruments
The width of the frame, in proportion to the double-
horse sward-cutter, is as four to six. of Huiban-
dry.

It is recommended for a double-horse sward-cutter to have eight bulls and wheels, in order that when it is used to reduce hard clody summer-fallow, or land for barley, before the last furrow, or even after it, the whole weight (42 stone) employed in cutting the stiffest land and toughest sward, may be applied to the 8 bulls then at 6 inches from one another. The 64lb. weights to be applied to 6 of the bulls, and two of the 48lb. weights to each of the additional bulls, which is a sufficient weight for that purpose, and will effectually prevent a clod of more than six inches breadth from escaping being broke into pieces.

In the same manner, a single-horse sward-cutter may have six bulls for the above-mentioned purpose; the 28 stone belonging to it divided thus: The 64lb. weights to four of the bulls, and two of the 48lb. weights to each of the additional bulls.

That the machine may come as cheap as possible to the public, the inventor is of opinion, that the expence of the two wheels and the iron axle (which is considerable) may be saved, by joining strongly to the frame a piece of wood with a little curve at the extremity of it, resembling the foot of a sledge formerly much used in Scotland to carry in the corn from the field; the part of it resting on the ground being kept 18 inches (the half diameter of the wheels) from the frame by a strong support of wood.

As the two outer bulls next the frame are apt to get under it, so as to prevent the cutting wheels from being taken out of the ground, a thin slip of iron fixed

Instruments to the inside of the frame, nearly opposite to the back of Huban-dry. end of the bulls, of convenient length, will be found necessary.

The original intention of this machine was to prepare old grass ground for the plough, by cutting it across the ridges, in the beginning of or during winter, when the ground is soft, in order to answer all the purposes that Mr Tull proposed by his four-coulter plough above described, and so strongly recommended by him for bringing into tilth grass ground that has been long rested. This the sward-cutter has been found to do much more effectually and expeditiously: For Mr Tull's machine cuts the sward in the same direction with the plough; and is liable, from every obstruction any of the coulters meet with, to be thrown out of its work altogether, or the instrument broken; to which the sward-cutter, consisting of four, six, or more cutting wheels, is never liable, from these being entirely independent of one another, cutting the ground across the ridges before ploughing, and rendering that operation easier to two horses than it would be to three without its being cut. The furrow being cut across, falls finely from the plough in squares of any size required, not under six inches, in place of long slips of tough sward seldom and imperfectly broken by the four-coulted plough.

This instrument is very fit for preparing ground for burnbating, as it will save much hard labour.

It may be properly used in cross-cutting clover of one or two years standing, to prepare the ground for wheat, if the land is stiff and moist enough.

It may be applied to cutting and cross-cutting pasture ground, intended to have manure of any kind put upon

upon it to meliorate the grass. In this it will far exceed the scarificator mentioned in one of Mr Young's tours; as that instrument is liable, as well as the four-coulted plough, to be thrown out of its work when meeting with a stone or other interruption. This the sward-cutter is proof against, which is looked on as its greatest excellence.

In preparing for barley, the sward-cutter excels a roller of any kind in reducing the large hard clods in clay land, occasioned by a sudden drought, after its being ploughed too wet; and it is likewise very proper for reducing such clay land when under a summer fallow. In this operation, the sward-cutter is greatly to be preferred to the cutting-roller, likewise mentioned by Mr Young in one of his tours; for the wheels of the latter being all dependent one on another, when one is thrown out by a stone, three or four must share the same fate. Besides, the cutting-roller has but seven wheels in six feet; whereas the sward-cutter has six in four feet three inches, at nine inches distant; and, if necessary, may have them so near as six inches.

After old grass ground is cut across with the sward-cutter and ploughed, it has a very uncommon and worklike appearance, from each square turned over by the plough being raised up an inch or two at the side last moved by the earthboard; so that the field, when finished, is all prettily waved, and resembles a piece of water when blown on by a gentle breeze. By this means a very great deal of the land's surface is exposed to the frost and other influences of the air, which cannot fail to have a good effect on it.

Two horses are sufficient for the draught of a double-horse

Instruments horse sward-cutter, and one horse for a single-horse one.
of Huban-
dry.

One man manages the machine and drives the horses. He begins his operation by first measuring off 20 or 30 paces from the machine, less or more as he inclines, and there fixes a pole. He then cuts the field cross, as near at right angles with the ridges as he can. When the cutting wheels are past the last furrow about a yard or so, and the machine is upon the utmost ridge of the field on which it must turn, he must stop the horses; then take hold of the lever I, fig. 1. and by pulling it to him he raises the cutting wheels out of the ground, which are kept so by the loop of the rope being put over the pin R, in the lever I, fig. 2. till the machine is turned and brought to its proper place, which is done by measuring off the same distance formerly done on the opposite side of the field. When the cutting wheels are exactly over the outmost furrow, then, on the horses being stopped, the rope is slipt off the pin R, and the lever returned to its former place, as represented fig. 1. which allows the weights LL, &c. to force the cutting wheels into the ground again. He then goes on until the interval betwixt the first and second stroke of the machine is all cut. In this manner the field is to be finished, after which you may begin to plough when you please. (N. B. There must be a pole at each side of the field.)

It is of no consequence whether the land to be sward-cut is in crooked ridges or straight, in flat ridges or in very high raised ones. Be the surface ever so uneven, the cutting wheels, being all independent of one another, are forced by their weights into every furrow or hollow.

One

One sward-cutter will cut as much in one day as six Instruments of Husbandry.
ploughs will plough.

The land may lie several months in winter after being sward-cut, when there is no vegetation to make the cuts grow together again before it is ploughed; but the sooner it is ploughed after cutting the better, that it may have the benefit of all the winter's frost, which makes it harrow better at seed time.

When the ground is harrowed, the harrows ought to go with the waves which appear after ploughing, not against them, as by that means they are less apt to tear up the furrows all cut into squares. This, however, need only be attended to the two first times of harrowing, as they are called.

Any common wright and smith may make the instrument. It is very strong, very simple, and easily managed and moved from place to place; and, if put under cover, will last many years.

It was invented some time ago by the Honourable Robert Sandilands; and is represented in the plate as it has been lately improved by him, the price being at the same time reduced from 15l. or 16. to 5l. or 6l.

3. The Cultivator.

This instrument was invented by Mr William Lester of Northampton; and that gentleman received, from the Society for the encouragement of Arts, the Society's silver medal. The purpose of this instrument is to pulverize tenacious soils that have been once ploughed, in a much more complete and rapid manner than can be accomplished by any other instrument. It is thus described, Plate XIII. fig. 3.—A, the beam; BB, the handles; CC, a cross bar of a semicircular form containing

Instruments taining a number of holes, which allow the two bars of Hulban dry.

DD are two strong bars moveable at one end upon a pivot E, and extending from thence in a triangular form to the cross bar C. In these bars are square holes, which allow the shares F placed therein to be fixed to any height required.

The seven shares marked F, are shaped at their lower extremities like small trowels; the upper parts of them are square iron bars.

GGG are three iron wheels on which the machine is moved; they may be raised or lowered at pleasure.

H, the iron hook to which the swingle-tree and horses are to be fixed.

When the machine is first employed on the land, the bars DD are expanded as much as possible. As the soil is more loosened, they are brought nearer to the centre; the shares then occupy a less space, and the soil will consequently be better pulverized.

In working on a rough fallow, therefore, the cultivator should be set for its greatest expansion, and contracted in proportion as the clods are reduced. The inventor declares himself confident that one man, a boy, and six horses, will move as much land in a day, and as effectually, as six ploughs, meaning land in a fallow state that has been previously ploughed. It is requisite in some states of the soil to alter the breadth of the shares, but of this it is presumed that every farmer will be a proper judge. By the expansion and contraction of the cultivator, the points of the shares are in a small degree moved out of the direct line; but this is said to be trifling as to prove no impediment to its working.

A certificate from Mr William Shaw of Cottenham,

near Northampton, states, that he had used Mr Lester's cultivator, upon a turnip fallow in summer 1800; Instruments of Husbandry. and that he believes it to be a very useful implement for cultivating the land in a fallow state by its working or scuffling off seven acres per day with six horses. He adds, that from its property of contracting and expanding, it is calculated to work the same land in a rough or fine state, by which means it unites the principles of two implements in one, and by the index on the axis it may be worked at any depth if required.

4. *The Brake.*

The brake is a large and weighty harrow, the purpose of which is to reduce a stubborn soil, where an ordinary harrow makes little impression. It consists of fig. 2. Brake described, Plate III. four square bulls, each side five inches, and six feet and a half in length. The teeth are 17 inches long, bending forward like a coulter. Four of them are inserted into each bull, fixed above with a screw-nut, having 12 inches free below, with a heel close to the under part of the bull, to prevent it from being pushed back by stones. The nut above makes it easy to be taken out for sharpening. This brake requires four horses or four oxen. One of a lesser size will not fully answer the purpose: one of a larger size will require six oxen; in which case the work may be performed at less expence with the plough.

This instrument may be applied to great advantage uses. in the following circumstances. In the fallowing strong clay that requires frequent ploughings, a braking between every ploughing will pulverize the soil, and render the subsequent ploughings more easy. In the month of March or April, when strong ground is ploughed for

Instruments for barley, especially if bound with couch-gras, a cross-braking is preferable to a cross-ploughing, and is done at half the expence. When ground is ploughed from the state of nature, and after a competent time is cross-ploughed, the brake is applied with great success, immediately after the cross-ploughing, to reduce the whole to proper tilth.

Let it be observed, that a brake with a greater number of teeth than above mentioned, is improper for ground that is bound together by the roots of plants, which is always the case of ground new broken up from its natural state. The brake is soon choked, and can do no execution till freed from the earth it holds. A less number of teeth would be deficient in pulverizing the soil.

4. *The Harrow.*

Harrows are too frequently considered as of no use but to cover the seed; but they have another use scarce less essential, which is, to prepare land for the seed. This is an article of importance for producing a good crop. But how imperfectly either of these purposes is performed by the common harrow, will appear from the following account of it.

Imperfection of the common harrow.

The harrow commonly used is of different forms. The first we shall mention has two bulls, four feet long and 18 inches asunder, with four wooden teeth in each. A second has three bulls, and 12 wooden teeth. A third has four bulls and 20 teeth of wood or iron, 10, 11, or 12 inches asunder. Now, in fine mould, the last may be sufficient for covering the seed; but none of them are sufficient to prepare for the seed any ground that requires subduing. The only tolerable

form is that with iron teeth ; and the bare description Instruments
of Husbandry. of its imperfections will show the necessity of a more perfect form. In the first place, this harrow is by far too light for ground new taken up from the state of nature, for clays hardened with spring drought, or for other stubborn soils : it floats on the surface ; and after frequent returns in the same track, nothing is done effectually. In the next place, the teeth are too thick set, by which the harrow is apt to be choked, especially where the earth is bound with roots, which is commonly the case. At the same time, the lightness and number of teeth keep the harrow upon the surface, and prevent one of its capital purposes, that of dividing the soil : nor will fewer teeth answer for covering the seed properly. In the third place, the teeth are too short for reducing a coarse soil to proper tilth ; and yet it would be in vain to make them longer, because the harrow is too light for going deep into the ground. Further, the common harrows are so ill constructed, as to ride at every turn one upon another. Much time is lost in disengaging them. Lastly, It is equally unfit for extirpating weeds. The ground is frequently so bound with couch-grafs, as to make the furrow-slice stand upright, as when old ley is ploughed : notwithstanding much labour, the grafts roots keep the field, and gain the victory.

A little reflection, even without experience, will make it evident, that the same harrows, whatever be the form, can never answer all the different purposes of harrowing, nor can operate equally in all different soils, rough or smooth, firm or loose. The following, therefore, have been recommended ; which are of three different forms, adapted for different purposes. They

Fig. 1. Instruments of Husbandry. Birch is the best wood for them, because it is cheap, and not apt to split. The first is composed of four bulls, each four feet ten inches long, three inches and a quarter broad and three and a half deep; the interval between the bulls 11 inches and three fourths; so that the breadth of the whole harrow is four feet, The bulls are connected by four sheths, which go through each bull, and are fixed by timber nails driven through both. In each bull five teeth are inserted, ten inches free under the bull, and ten inches asunder. They are of the same form with those of the brake, and inserted into the wood in the same manner. Each of these teeth is three pounds weight: and where the harrow is made of birch, the weight of the whole is six stone 14 pounds, Dutch. An erect bridle is fixed at a corner of the harrow, three inches high, with four notches for drawing higher or lower. To this bridle a double tree is fixed for two horses drawing abreast, as in a plough. And to strengthen the harrow, a flat rod of iron is nailed upon the harrow from corner to corner in the line of the draught.

Fig. 2. The second harrow consists of two parts, connected together by a crank or hinge in the middle, and two chains of equal length, one at each end, which keep the two parts always parallel, and at the same distance from each other. The crank is so contrived, as to allow the two parts to ply to the ground like two unconnected harrows; but neither of them to rise above the other, more than if they were a single harrow without a joint. In a word, they may form an angle downward, but not upward. Thus they have the effect of two harrows in curved ground, and of one weighty

weighty harrow in a plain. This harrow is composed Instruments
of six bulls, each four feet long, three inches broad, of Husbandry.
and three and a half deep. The interval between the
bulls nine inches and a half; which makes the breadth
of the whole harrow, including the length of the crank,
to be five feet five inches. Each bull has five teeth,
nine inches free under the wood, and ten inches asunder.
The weight of each tooth is two pounds; the
rest as in the former.

The third consists also of two parts, connected together like that last mentioned. It has eight bulls, each four feet long, two inches and a half broad, and three deep. The interval between the bulls is eight inches; and the breadth of the whole harrow, including the length of the crank, is six feet four inches. In each bull are inserted five teeth, seven inches free under the wood, and ten inches and a half asunder, each tooth weighing one pound. The rest as in the two former harrows.

These harrows are a considerable improvement. They Properties
ply to curved ground like two unconnected harrows; of these
and when drawn in one plane, they are in effect one harrows.
harrow of double weight, which makes the teeth pierce
deep into the ground. The imperfection of common
harrowes, mentioned above, will suggest the advantages
of the set of harrows here recommended. The first is
proper for harrowing land that has long lain after
ploughing, as where oats are sown on a winter furrow,
and in general for harrowing stiff land: it pierces deep
into the soil by its long teeth, and divides it minutely.
The second is intended for covering the seed: its long
teeth lays the seed deeper than the common harrow can
do; which is no slight advantage. By placing the seed
S 2 considerably

Instruments considerably under the surface, the young plants are, of Husbandry. on the one hand, protected from too much heat, and, on the other, have sufficiency of moisture. At the same time, the seed is so well covered that none of it is lost. Seed slightly covered by the common harrows wants moisture, and is burnt up by the sun ; beside, that a proportion of it is left upon the surface uncovered. The third harrow supplies what may be deficient in the second, by smoothing the surface, and covering the seed more accurately. The three harrows make the ground finer and finer, as heckles do lint ; or, to use a different comparison, the first harrow makes the bed, the second lays the seed in it, the third smooths the clothes. They have another advantage not inferior to any mentioned : they mix manure with the soil more intimately than can be done by common harrows ; and upon such intimate mixture depends greatly the effect of manure, as has already been explained. To conclude, these harrows are contrived to answer an established principle in agriculture, That fertility depends greatly on pulverizing the soil, and on an intimate mixture of manure with it, whether dung, lime, marl, or any other.

Plate IV. The *Chain and Screw Harrow*. Fig. 6. is the plan of a harrow invented by Mr Sandilands, and to which he has given the name of the *chain and screw harrow*. Its properties are, that if your ridges be high, and you wish to harrow them from one end to the other, by lengthening the chain (which the screw commands), the harrow, when drawn along, forms an angle downwards, and misses none of the curve of the ridge, so far as it extends (which may be nine feet, the distance from A to B. The extent, in the contrary direction,

rection, is five feet six inches). When the crowns of Instruments of Hufban-
the ridges have got what is thought a sufficient harrow-
ing lengthwise, you shorten the chain by the screw, dry.
which forms an angle upwards; the harrow is then
drawn by the horses, one on each side of the furrow;
which completely harrows it, and the side of the ridges,
if 18 feet broad.

When you want to harrow even ground or high
ridges across with the screw, you can bring the har-
row to be horizontal, so as to work as a solid harrow
without a joint,

The teeth are formed and fixed in the common man-
ner, square, not in the fashion of coulters; and are nine
or ten inches below the wood, and of such strength as
it is thought the land requires. The teeth cut, or ra-
ther tear, the ground at every four inches without va-
riation, though seemingly placed irregularly; and this
without any risk of choking, except sometimes at the ex-
treme angles, where the teeth are necessarily near each
other; but which may be cleaned with the greatest
ease, by raising them a little from the ground. The
figures 1, 2, &c. point out where the 12 teeth on each
side of the harrow are placed.

Where a strong brake-harrow is not necessary, by
making the teeth shorter and lighter you may have 48
teeth, which will tear the ground at every two inches,
cover the seed well, and make a fine mould.

It is recommended, that harrows for every purpose,
and of any size, be made on the above principle; by
which no tooth can ever follow the track of another,
and all of them will be kept constantly acting.

Instruments
of Husban-
dry.

The roller.

5. *The Roller.*

The roller is an instrument of capital use in husbandry, though, till of late years, scarcely known in ordinary practice; and where introduced, it is commonly so slight as to have very little effect.

Rollers are of different kinds; stone, cast-iron, wood. Each of these has its advantages. We would recommend the last, constructed in the following manner: Take the body of a tree, six feet ten inches long, the larger the better, made as near a perfect cylinder as possible. Surround this cylinder with three rows of fillies, one row in the middle, and one at each end. Line these fillies with planks of wood equally long with the roller, and so narrow as to ply into a circle. Bind them fast together with iron rings. Beech wood is the best, being hard and tough. The roller, thus mounted, ought to have a diameter of three feet ten inches. It has a double pair of shafts for two horses abreast. These are sufficient in level ground; in ground not level, four horses may be necessary. The roller without the shafts ought to weigh 200 stone Dutch; and the large diameter makes this great weight easy to be drawn.

Season for
rolling.

Rolling wheat in the month of April is an important article in loose soil; as the winter rains pressing down the soil leave many roots in the air. Barley ought to be rolled immediately after the seed is sown; especially where grass seeds are sown with it. The best time for rolling a gravelly soil, is as soon as the mould is so dry as to bear the roller without clinging to it. A clay soil ought neither to be tilled, harrowed, nor rolled, till the field be perfectly dry. And as roll-

ing

ing a clay soil is chiefly intended for smoothing the surface, a dry season may be patiently waited for, even till the crop be three inches high. There is the greater reason for this precaution, because much rain immediately after rolling is apt to cake the surface when drought follows. Oats in a light soil may be rolled immediately after the seed is sown, unless the ground be so wet as to cling to the roller. In a clay soil, delay rolling till the grain be above ground. The proper time for sowing grass seeds in an oat field, is when the grain is three inches high; and rolling should immediately succeed, whatever the soil be. Flax ought to be rolled immediately after sowing. This should never be neglected; for it makes the seed push equally, and prevents after-growth; the bad effect of which is visible in every step of the process for dressing flax. The first year's crop of sown grasses ought to be rolled as early the next spring as the ground will bear the horses. It fixes all the roots precisely as in the case of wheat. Rolling the second and third crops in loose soil is an useful work; though not so essential as rolling the first crop.

In the first place, rolling renders a loose soil more compact and solid ; which encourages the growth of plants, by making the earth adhere close to every part of every root. Nor need we be afraid of rendering the soil too compact ; for no roller that can be drawn by two or four horses will have that effect. In the next place, rolling keeps in the moisture, and hinders drought to penetrate. This effect is of great moment. In a dry season, it may make the difference of a good crop, or no crop, especially where the soil is light. In the third place, the rolling grafts seeds, beside the foregoing

Instruments advantages, facilitates the mowing for hay; and it is to
of Husbandry,
dry. be hoped, that the advantage of this practice will lead
farmers to mow their corn also, which will increase
the quantity of straw both for food and for the dung-
hill.

There is a small roller for breaking clods in land intended for barley. The common way is, to break clods with a mallet; which requires many hands, and is a laborious work. This roller performs the work more effectually, and at much less expence. Let a harrowing precede, which will break the clods a little; and after lying a day, or a day and a half, to dry, this roller will dissolve them into powder. This however does not supersede the use of the great roller after all the other articles are finished, in order to make the soil compact, and to keep out the summer drought. A stone roller four feet long, and fifteen inches diameter, drawn by one horse, is sufficient to break clods that are easily dissolved by pressure. The use of this roller in preparing land for barley is gaining ground daily, even among ordinary tenants, who have become sensible both of the expence and toil of using wooden mells. But in a clay soil, the clods are sometimes too firm, or too tough, to be subdued by so light a machine. In that case, a roller of the same size, but of a different construction, is necessary. It ought to be surrounded with circles of iron, six inches asunder, and seven inches deep; which will cut even the most stubborn clods, and reduce them to powder. Let not this instrument be considered as a finical refinement. In a stiff clay it may make the difference of a plentiful or scanty crop.

6. *The*

6. *The Fallow-cleansing Machine.*

Instruments
of Husban-
dry.

The fallow-
cleansing
machine.
Plate VI.
fig. 4.

This was invented by Mr Aaron Ogden, a smith at Ashton-under-Line, near Manchester in Lancashire. It is intended for cleansing fallows from weeds, &c. which exhaust the riches of the soil. A, A, is the frame; B, the first roller; C, the second ditto; in which last are two cranks to move the arms D, D, which work the rake up the directors fixed on the plank E. The under side of the lower ends or shares of these directors are sharp, to cut the clods and let them come on the upper side. Each alternate heel of the share is longer than the intermediate one, that they may not have more than one-half to cut at once. At the back of the plank E are two screws to let it loose, that the directors may be set higher or lower. The shares are to penetrate the ground two or three inches, to raise the quicks till the rake I, I, fetches them into the cart H, where a man must be ready with a muck-hook to clear them backward when gathered. In the rake I are two teeth for every space of the directors, that stones, &c. may be gathered without damage. K, K, are two staples, by which the machine is drawn: under them at b are two hooks, placed low to raise the machine in turning, by the help of the traces; and the axle-tree of the cart should be fixed upon a pin, that it may turn like a waggon. F, F, are the triggers to throw the rake behind the roots. The long teeth at G, G, are to cleanse the roller C. I, I, is the rake which gathers up the weeds into the cart H, and is drawn above the trigger F by the working of the arms D, expressed by the dotted lines at d d, i i i. The triggers F, of which there is one on each side, move on the pivots a; so that when

the

Instruments the points *b* of the rake I have been drawn up by the
 of Hubban-
 dry. directors *E* to the part marked *c*, the trigger, giving
 way, permits the rake to pass; but immediately fall-
 ing, the rake returns along the upper surface of the
 trigger marked *e*, *e*, and of course falls on the weeds
 when it comes to the end, a little beyond the pivot *a*.
 The reader will observe, that the boarding is taken
 away on one side, in the Plate, in order to give a more
 perfect view of the inner parts of the machine; and
 in fact it would perhaps be better if all the boarding,
 marked *L*, *L*, *L*, was taken away, and frame-work
 put in its stead. The cart *H* might undoubtedly also

Plate VI. Fig. 2. be made lighter. The wheels *M*, *M*, appear in the
 Plate to be made of solid wood: but there is no ne-
 cessity they should be so. At *N*, is another view of
 the roller *C*, by which the disposition of the spikes
 may be easily comprehended. Suppose the circle *O*,
 described by the end of the roller *N*, to be divided by
 four straight lines into eight equal segments, as repre-
 sented at *P*. Let the same be done at the other end of
 the roller, and parallel lines be drawn from one corre-
 sponding point to the other the length of the roller;
 mark the points with figures 1, 2, 3, 4, 5, 6, 7, 8; after-
 wards draw oblique lines, as from 1, at the end of
O, to 2, at the other end, and from 2 to 3, &c.: on
 these oblique lines the spikes are to be fixed at equal
 distances, in eight circles, described on the circumfe-
 rence of the roller. The spikes of the small roller *B*
 are fixed in the same manner, except that the diameter
 being smaller, there are only six instead of eight rows.
 Fig. 3. R is another view of the directors, with the plank *E*
 Fig. 5. on which they are fixed; and S is a section of a part
 of the plank, with one of the directors as fixed, in
 which

which may be seen the heel *m*, from whence to the point of the share *n* is a sharp cutting edge. See the same letters in figure R. At T is one of the long teeth to be seen at G; it is bent towards the roller C, which it serves to cleanse. When the end of the rake *b*, after rising above *c*, is pushed, by the motion of the arms D, D, along the upper part *e*, *e*, of the trigger F, and comes to the end beyond *a*; as it falls, the part of the arm marked *o* rests on the notch *p*, till it is again raised by the motion of the roller C with the rake. The roller C is to be one foot diameter, the spikes nine inches long, that they may go through the furrow (if the soil should be loose) into the hard earth, the more effectually to work the rake, which otherwise might be so overcharged as to cause the roller to drag without turning. In the rake-ends *b* there should be pivots, with rollers or pullers on, to go in the groove, to take off the friction; and they would likewise take the triggers more surely as the rake comes back. The rake should also be hung so far backward, that when it is fallen the arms of it may lie in the same plane or parallel with the directors, on which it comes up (which will require the frame to be two inches longer in the model). This will cause the rake to fall heavier, and drive the teeth into the roots, and bring them up without shattering. These teeth must be made of steel, very fine, and so long as to reach down to the plank on which the directors are fixed, that is to say, six inches long (the directors are also to be made six inches broad above the plank). The rake-head should also fall a little before the crank is at its extremity, which will cause the rake to push forward to let the teeth come into the roots. The rake-teeth must

Instruments of Husbandry.

must drop in the same plane with the roller and wheels, or on the surface of the earth. No more space should be given from the roller C to the long teeth at G G than that the rake may just miss the spikes of the roller C and fall on the places before mentioned. As the first roller B was intended to cleanse the second C more than for any other use, it may be omitted when the machine is made in large, as Mr Ogden has lately found that the long teeth at GG answer the end alone, and this renders the machine about a sixth part shorter. Now, to suit any sort of earth, there should be to each machine three planks, with directors at different spaces to use occasionally : in the first, the spaces between the directors should be eight inches wide, in the second six, and in the third four. This will answer the same end as having so many machines.

As there may be some objections to the rake not leaving the roots when it has brought them up, Mr Ogden has several methods of cleansing it ; but as he would make it as simple as possible, he chooses to let it be without them at present ; but suppose it should bring some roots back again with it, it will probably lose them before it gets back to the extremity ; whence they will lie light, and be of but little detriment to the others coming up. Mr Ogden would have the first machine made four feet six inches wide, the teeth divided into equal spaces, the outsides into half spaces.

7. *The new-invented Patent Universal Sowing Machine.*

Universal sowing machine.

Plate VII. drawn by a horse, or fixed to a plough, and used with fig. 2. 3. and Plate VIII. it, is extremely simple in the construction, and not fig. 9. liable to be put out of order ; as there is but one movement

movement to direct the whole, nor does it require any skill in working. It will sow wheat, barley, oats, rye, clover, cole-seed, hemp, flax, canary, rape, turnip, besides a great variety of other kinds of grain and seeds broad-cast, with an accuracy hitherto unknown. It is equally useful in the new husbandry, particularly when fixed to a plough; it will then drill a more extensive variety of grain, pulse, and seed (through every gradation, with regard to quantity), and deliver each kind with greater regularity than any drill-plough whatever. When used in this manner, it will likewise be found of the utmost service to farmers who are partial to the old husbandry, as, among many other very valuable and peculiar properties, it will not only sow in the broad-cast way with the most singular exactness, but save the expence of a seedsmen; the seed being sown (either over or under furrow at pleasure), and the land ploughed, at the same operation.

Perhaps a fair and decisive experiment for ascertaining the superior advantage of broad-casting or drilling any particular crop, was never before so practicable; as the seed may now be put in with the utmost degree of regularity, in both methods of culture, by the same machine; consequently, the seed will be sown in both cases with equal accuracy, without which it is impossible to make a just decision.

The excellence of this machine consists in spreading any given quantity of seed over any given number of acres with a mathematical exactness, which cannot be done by hand; by which a great saving may be made in feeding the ground, as well as benefiting the expected crop.

There has always been a difficulty in sowing turnip seed

~~instruments~~ seed with any degree of exactness, both from the ~~mi-~~ nuteness of the seed, and the smallness of the quantity required to be sown on an acre. Here the machine has a manifest advantage, as it may be set to sow the least quantity ever required on an acre; and with an accuracy the best seedsman can never attain to.

It will also sow clover, cole, flax, and every other kind of small seed, with the utmost degree of regularity.

It will likewise broad-cast beans, pease, and tares, or drill them with the greatest exactness, particularly when constructed to be used with a plough.

Another advantage attending the use of this machine is, that the wind can have no effect on the falling of the seed.

Of the Machine when made to be used without a Plough, and to be drawn by a Horse.—It may in this case be made of different lengths at the desire of the pur-

Plate VII. ^{fig. 2.} chaser. The upper part AAAA, contains the hoppers from which the grain or seed descends into the spouts. The several spouts all rest upon a bar, which hangs and plays freely by two diagonal supports BB; a trigger fixed to this bar bears a catch-wheel; this being fixed on the axle, occasions a regular and continual motion, or jogging of the spouts, quicker or slower in proportion to the pace the person sowing with it drives; and of course, if he quickens his pace, the bar will receive a greater number of strokes from the catch-wheel, and the grain or seed will feed the faster. If he drives slower, by receiving fewer strokes, the contrary must take place. In going along the side of a hill, the strength of the stroke is corrected by a spring which acts with more or less power, in proportion as the machine is

more or less from the horizontal position, and counter-
acts the difference of gravity in the bar, so that it pres-
ses, in all situations, with a proper force against the
catch-wheel. This spring is unnecessary if the land
be pretty level. At the bottom of the machine is placed
an apron or shelf in a sloping position; and the corn or
seed, by falling thereon from the spouts above, is scat-
tered about in every direction under the machine, and
covers the ground in a most regular and uniform man-
ner.

To sow the corn or seed in drills, there are moveable
spouts (see fig. 8.), which are fixed on or taken off at Plate VIII.
pleasure, to direct the seed from the upper spout to the
bottom of the furrow.

The machine is regulated for sowing any particular
quantity of seed on an acre by a brass slider, A, fig. 7.
fixed by screws against a brass bridge on each of the
spouts. The machine is prevented from feeding while
turning at the ends, by only removing the lever E,
fig. 3. out of the channel G, to another at H, on the Plate VII. |
right hand of it, which carries back the bar from the
catch-wheel, and occasions the motion of the spouts to
cease, and at the same time brings them upon a level
by the action of the diagonal supporters; so that no
corn or seed can fall from them.

The machine in this form is particularly useful for
broad-casting clover upon barley or wheat; or for sow-
ing any other kind of seed, where it is necessary that
the land should first be harrowed exceedingly fine and
even.

Manner of using the Machine, when drawn by a Horse.—Place the machine about two feet from the
ends of the furrows where you intend it shall begin to
sow.

PRACTICE OF

the hoppers with seed, and drive it forwards near outside wheel in the first furrow. When you reach the end of the length, at the opposite side of the field, let the lever E, fig. 3. into the channel H, and the machine will instantly stop sowing. Drive it on for two feet, and then turn. Fill the hoppers again with seed; then remove the lever back again into the channel G, and in returning, let the outside wheel of the machine go one furrow within the track which was made by it, in passing from the opposite end; as for example, if the wheel passed down the eighth furrow from the outside of the field, let it return in the ninth; and in every following length let the outside wheel always run one furrow within the track made by the same wheel: because the breadth sown is about nine inches less than the distance between the wheels.

Let the machine be kept in a perpendicular situation. If the farmer wishes to sow more or less seed on any one part of the field than the other, it is only raising the handles a little higher, or sinking them a little lower than usual, and it will occasion a sufficient alteration; and should the last turn be less in breadth than the machine, those spouts which are not wanted may be taken up from the bar, and prevented from feeding, by turning the knob above them.

Also, when the land required to be sown has what is called a *vent*, that is, when the sides of the field run in an oblique line to the furrows, which by this means are unequal in length; the spouts must be taken up or let down in succession by turning the knobs, as that part of the machine where they are placed arrives at the ends of the furrows. This is done while the machine is going forwards.

The machine may be Instruments
of Husbandry.
The machine may dry.
... boy.

...—In each spout is
Plate VII.), with an aperture
... used to pass through. This aper-
... ture is regulated by a slider, A, which passes
... firmly fixed for the quantity of seed
... sown on an acre, is fastened by means
... of a screw, which bears firmly against the bridge. This
... slider is used in sowing all kinds of seed, where it is
... required to sow from one bushel upwards on an acre.
... one, two, three gallons, or any of the inter-
... mediate quantities, as of clover, cole-feed, &c. the
... brass plate, fig. 4. is placed between the bridge and the Plate VIII.
... slider, with the largest aperture B downwards, which
... aperture is enlarged or contracted by the slider as before. To sow turnips, the same plate is placed between
... the bridge and the slider, with its smallest aperture A
... downwards, and the hollow part about the same aper-
... ture inwards.

Fig. 6. is a view of the regulator, by which the
apertures in the several spouts are all set exactly alike,
with the utmost ease, to make them feed equally. The
extreme height of the largest aperture is equal to the
breadth AB, and the breadth at C is equal to the
height of the smallest aperture used, viz. that for tur-
nips. The side AC is divided into 60 equal parts,
and on it moves the slider or horse D; which being
placed at any particular degree, according to the quan-
tity of seed required to be sown on an acre, is fixed
upon it, by a screw on the side of the slider or horse.
When this is done, the end of the regulator is put

Instruments through the aperture in the bridge or plate (whichever is intended to be used), and the slider against the bridge in the spout, raised by it, till it stops against the horse on the regulator : then the slider is fastened against the bridge firmly by the two screws ; care being taken at the same time that it stand nearly square.

By this means the spouts (being all fixed in the same manner) will feed equally.

It is easy to conceive that the size of the apertures, and consequently the quantity of seed to be sown on an acre, may be regulated with a far greater accuracy than is required in common practice.

The spouts may be regulated with the utmost nicety, in five minutes, to sow each particular seed, for the whole season. But a little practice will enable any person, who possesses but a very moderate capacity, to make the spouts feed equally, even without using the regulator *.

Of

* Proper directions are given with each machine for using it, as also for fixing the sliders to sow any particular quantity of corn or seed on an acre, so as to enable any person to set the spouts.

The prices of the machine (exclusive of the packing cases) are as follows. If constructed to be used with a single-furrow plough ; the wheel, with the axle and cheeks steeled, strap, regulator, brass-plates for broad-casting or drilling turnips, lucerne, tares, wheat, barley, &c. and every article necessary for fixing it included, three guineas and a half. If made with a spring (for sowing on the side of a hill, where the slope is considerable), but which is very rarely necessary, five shillings more. If made to be fixed to any double-furrow plough, four guineas and a half.

The large machine, fig. 3. Plate VII. when made to broad-cast seven furrows at a time and to be drawn by a horse, eight guineas and a half. If constructed to sow five furrows at a time, and to be used by hand, six guineas. These are also five shillings more if made with a spring.

Of the Machine, when made to be used by Hand.—*Instruments of Husbandry.*
The difference of the machine in this case is, that it is made lighter, with but three spouts, without shafts, and is driven forwards by the handles. It hath also a bolt in front, which being pushed in by the thumb, releases the machine; so that it can then easily be placed in a perpendicular position. This alteration is necessary to keep the handles of a convenient height, in sowing up and down a hill, where the slope is considerable; and is done while the machine is turning at the end of the length. The method of regulating and using it is the same as when made to be drawn by a horse.

Of the Machine, when constructed to be used with a Plough.—This is, without doubt, the most useful application of the machine; and it can be fixed without difficulty to any kind of plough, in the same manner as to that represented in fig. 2. Plate VII.

The advantages arising from the use of it are great and numerous; for, beside the increase in the crop, which will be ensured by the seeds being broad-cast with a mathematical nicety, a large proportion of seed (the value of which alone, in a few months, will amount to more than the price of the machine) and the seedsman's labour will be saved. The seed may likewise be sown either under or over furrow; or one cast each way, as is practised by some farmers. The seeds also, being cast by the machine upon the fresh ploughed land, may be immediately harrowed in, before the mould has lost any part of its moisture; which in a dry season will greatly promote the crop. In drilling any kind of grain, pulse, or feed, it possesses every property that can be wished for in the best drill-plough, nor will it (as most of them do) bruise the seed, or feed irre-

Instruments gularly. The construction of the machine is the same of Husban-
dr. as the large ones, except being made with one hopper
and spout instead of several, and the apron moveable
instead of being fixed, as may be seen by inspecting
fig. 1. Plate VIII. The only alteration necessary to
make the machine broad-cast or drill is, in the former case to place the apron B, fig. 2. Plate VII. at
the bottom of the machine, upon the hooks FF, sloping
either towards the furrows or the unploughed land,
according as it is intended to sow the seed, either over
or under furrow. Whenever the apron is required to
be shifted, it is done in less than a second of time; as
it only requires to be moved up or down with the hand,
when a catch fixes it.

To prepare it for drilling, instead of the apron, place
the long spout, fig. 8. Plate VIII. upon the brackets, on
the front of the machine, by the ears AA, to receive the
seed from the upper spout, and fasten the lower end of it,
by a small cord, to that hook upon which the apron is
hung for broad-casting which is next the plough (see
fig. 1. Plate VIII.); the seed will then be directed by
the long spout to the centre of the furrow, near the heel
of the plough. The spring for correcting the strength of
the stroke, is necessary only when they are required to
go along the side of a considerable declivity. The ma-
chine, when fixed to a plough, does not require the
smallest degree of skill in using, as nothing is necessary
but to keep the hopper filled, which will contain a suf-
ficient quantity of feed to go upwards of 140 rods, be-
fore it will want refilling, when three bushels and a
half are sown on an acre. The accuracy with which
it will broad-cast, may in some measure be conceived,
by considering that the seed regularly descends upon

the apron or shelf, and is from thence scattered upon the ground, in quantity exactly proportioned to the speed of the plough: also that each cast spreads to the third furrow: and by this means shuts upon the last. In this manner it is continually filling up till the whole field is completely covered; so that it is impossible to leave the smallest space without its proper quantity of seed.

When the plough is wanted for any other purpose, the machine, with the wheel at the heel of the plough for giving it motion, can be removed or replaced at any time in five minutes.

Fig. 9. represents the machine fixed to a double-furrow creasing plough, and prepared for drilling. As this plough may not be generally known, it will not be improper to observe, that it is chiefly used for creasing the land with furrows (after it has been once ploughed and harrowed); which method is necessary when the seed is to be sown broad-cast upon land that has been a clover ley, &c. because, if the seed be thrown upon the rough furrows, a considerable part of it will fall between them, and be unavoidably lost, by lying too deep buried in the earth. This mode answers extremely well, and partakes of both methods of culture; the seed, though sown broad-cast, falling chiefly into the furrows.

The machine is very useful for sowing in this manner; as the seed is broad-cast, with an inconceivable regularity, at the time the land is creased. The advantages it likewise possesses for drilling all sorts of grain or seed with this plough, are too evident to need mentioning.

The machine, when constructed to be used with a double-

~~Instruments~~ double-furrow plough, is made with two upper and
~~of Huban-~~
~~dry~~ two long spouts for drilling, two aprons for broad-
~~—~~ casting, and with a double hopper; but in other re-
~~spects~~ the same as when intended for a single-furrow
plough: it is used in all cases with the greatest ease
imaginable.

The interval between the points of the two shares of
a creasing plough is usually ten inches; the beam about
nine feet long; and the whole made of a light con-
struction.

Plate VII. *A more particular explanation of the figures.—Fig. 2.* The machine fixed to a Kentish turn wreat plough. A, The machine. B, The apron upon which the seed falls and rebounds upon the land, in broad-casting. C, Lid to cover the hopper. D, Wheel at the heel of the plough. E, Strap. FF, Hooks, upon which the apron turns by a pivot on each side. G, Stay, to keep the machine steady. H, Lever, to prevent it from sowing.

Fig. 3. The machine constructed to be drawn by a horse. AAAA, The hoppers. BB, The diagonal supporters. CCCC, The upper spouts. D, The apron or shelf upon which the seed falls from the upper spouts. E, The lever, which carries back the bar, and prevents the machine from sowing. FF, Staples upon the handles, through which the reins pass, for the man who conducts the machine, to direct the horse by. I, Screw, to fix the machine occasionally. N. B. The knobs (by turning which each particular spout may be taken from off the bar, and thereby prevented from feeding) are over each upper spout; but, to prevent confusion, are not lettered in the Plate.

Plate VIII. Fig. 1. is the same machine with that in fig. 2. Plate VII,

VII. The dotted lines, expressing the situation of the Instruments
of Husbandry,
long spout, when the apron is removed, and the ma-
chine adapted for drilling.

Fig. 2. Also the same machine, with the front laid open to show the inside. A, The catch-wheel fixed upon the axle. BB, The axle upon which the machine hangs between the handles of the plough. C, The pulley, by which the strap from the wheel at the heel of the plough turns the catch-wheel. D, the bar, upon which the upper spout rests, suspended by the diagonal supporters EE, bearing against the catch-wheel by the trigger F, and thereby kept in motion while the plough is going. G, The apron in a sloping position, upon which the corn or seed falls from the upper spout, and is scattered by rebounding upon the land. It turns upon pivots, and by this means throws the seed either towards the right hand or left at pleasure.

Fig. 3. The upper spout.

Fig. 4. The plate which is placed between the bridge and the slider, for sowing small seeds. The aperture A being downwards for sowing turnips; the larger one B downwards for sowing clover, &c.

Fig. 5. The bridge, fixed in the upper spouts. A, The slider, which contracts or enlarges the different apertures. B, The aperture in the bridge, through which the seed passes, when sowing any quantity from one bushel upwards on an acre.

Fig. 6. The regulator, made of brass. D, The slider or horse which moves upon it, and is fixed at any particular degree by a screw in its side.

Fig. 7. represents the movement in the machine fig. 3. Plate VII. AAAA, Cleets, between which the up-

Instruments of Husbandry. per spouts rest. BB, The diagonal supporters, by which the bar with the upper spouts hang. C, The catch-wheel. DD, The axle. E, The trigger upon the bar, which bears against the catch-wheel. FF, Stays from the back of the machine, by which the bar plays.

Plate VIII. Fig. 8. The long spout. AA, The ears by which it hangs.

Of the Threshing Machine.

We have already mentioned, that from the remotest antiquity the practice prevailed and still prevails in Asia, of treading out the corn from the ear by means of the feet of cattle. In the United States of America, where human labour is very expensive, the same mode of proceeding is still adopted. It also exists in the southern parts of Europe. Mr Young speaks of it as practised in the province of Languedoc and other parts, in the following terms *.—“*Languedoc.* Through all the southern parts of this province they tread out the corn with horses and mules; a man in the centre of the threshing-floor in the open air drives them round, and other men supply the floor and clear away the straw. In some conversation I had on this method between Narbonne and Nisslan, I was assured it was far preferable to the use of flails; that 24 mules or horses, and 12 men, would *depique*, as they term it, 150 septiers of wheat in a day; that some farms produce 2000 septiers of corn. What would flails do for such a quantity! I examined the wheat, and did not find it more damaged

* *Treatise*, vol. ii.

damaged than with flails ; but the climate is to be re-Instruments
membered, which makes the grain much harder than ^{of Husbandry.}
any with us. Seeing some flails going also, I demanded
the reason, and was told that the master would
sometimes have particular parcels of straw thrashed so,
to get the corn that was left in it, if he suspected too
much ; at others, the labourers desire to do it for
themselves, which is sometimes granted.

“ *Provence.*—Seeing a large quantity of the president’s wheat spread on cloths for drying in the sun, and inquiring what it meant ; I found it was washed, as all is, of which the best bread is made ; owing, beyond all doubt, to the mode of threshing, which renders it so foul, that this operation is necessary.”

The softness of the grain in our northern climates, together with the superior cleanliness of the operation, appears to have introduced at an early period, and to have rendered universal, the practice of separating the grain from the chaff and straw, by means of the flail, consisting of two sticks loosely attached to each other at one end by a rope ; the one being held in the hands, while with the other the sheaves of corn are beaten with repeated strokes. The laborious, tedious, and expensive nature of this operation, long induced farmers to wish that some mode could be contrived by means of mechanism, to abridge the toil of beating out the grain by flails. Accordingly, we understand that various attempts were made by ingenious men to construct a thrashing machine.

In particular, about the middle of the late century, Mr Menzies (of Culterallers, we believe, in the upper part of Clydesdale) constructed one which consisted of a number of flails moved by a water wheel. A Mr Stirling of Perthshire, contrived and used another upon

the

Instruments the principles of the flax mill. About the year 1773, of Huban-
dry. a Mr Ilderton at Alnwick erected a machine which acted upon the principle of rubbing or pressing out the corn. At the same time a Mr Oxley at Flodden framed one with skutchers, but of a defective nature, and possessing little * velocity. The late Sir Francis Kinloch of Gilmerton, Bart. brought to Scotland a model of Mr Ilderton's machine, which he sent to be tried by means of the water-wheel of a barley mill, belonging to Mr Andrew Meikle, civil engineer at Houston mill, near Haddington. It was torn to pieces in the trial, and when tried anew upon a larger scale, the same accident occurred. Mr Meikle himself, however, invented the new machine which is at present in use, and which is now known and employed not only in Britain, but also on the continent of Europe, and in America. We have learned with regret, that, like many other improvers of this most important of all arts, Mr Meikle has derived little or no emolument from his invention. The machine has received various improvements, or at least, alterations: but the following is, we believe, upon the whole, one of the most approved forms of its construction. N° 1. N° 2. and N° 3. are drawn to one-fourth of an inch to a foot, and N° 4. and N° 5. are drawn to one-half inch to a foot.

Plate XVI. N° 1. A, The conical wheel, commonly called the horse-wheel, working into a cast-iron pinion C, fixed on the axle D. On said axle is hung or fixed a spur-wheel E, working into a cast-iron pinion H, wedged on the drum spindle S, for driving the drum GGG. On the

the other end of the drum spindle is fixed a small conical pinion, six inches diameter, working two conical wheels, 12 inches diameter, O, fixed upon wrought iron spindles XX; on each end of spindles is fixed a pinion of six inches diameter, O, working a wheel of 12 inches diameter; the one fixed on the axle, for driving or moving the shaker F; the other end for driving the cast-iron feeding rollers I. On the said feeding roller are two small spindles K, each with a square socket going on the end of the spindles or gudgeons, fixed in the said feeding rollers I. On the said spindles K are fixed two small pinions ZZ, of equal diameter, for turning of the upper roller I, being about four inches diameter. PP, The two top rails of drum and shaker framing, supported by the posts tt, in N° 2. LLL, The beams for supporting the horse-wheel axle B. These beams are commonly supported from the barn wall, and stone pillars built for supporting the roof of horse courfe. m, m, m, m, The four levers fixed round the upright axle B that the horses are yoked to. n, n, n, n, n, n, The arms of the horse-wheel A. In N° 2. Plate XVII. and N° 3. Plate XVIII. is a wheel R, for supporting the arms of horse-wheel A, &c. S, Bolster and framing for supporting the foot of upright shaft.

The said reference for N° 1. describes N° 2. and N° 3.

N° 4. exhibits the corn-bruisers.

Plate XIX.

a, Cast-iron fly-wheel fixed on the end of one of the rollers dd, wrought by a handle b. This machine is wrought with a handle, either from the fly or from the cast-iron spur-wheel, C, working the pinions oo on the end of the rollers. The handles on the spur-wheel may be taken off, and wrought easily with one man, from

Instruments of Husbandry. from the handle on the fly *b*. The hopper, *A*, is supported between the posts *ff*, with a feeding board at the bottom, moved up and down with a pinion of four teeth fixed on the end of one of the rollers, for feeding and spreading the corn equally between the rollers, *dd*, where the corn passes through into a drawer or box *e*. The rollers *dd* are regulated by two iron screws going through the two posts *ff*, to answer the bruising of all kinds of grain.

Plate XIX. N° 5. is the straw-cutter.

A, The fly wrought by the handle *B*. On the same axle the fly is on there is an endless face-wheel *C*, working two pinions *DD*. These pinions are fixed on the end of two small iron spindles, going through the wooden rollers covered with pierced iron, for feeding forward the straw through the opening *X*, where the straw or hay is cut by the three knives *EEE*, screwed to the arms of the fly-wheel *A*. The iron frame *F* moves from the centre *P*, with a round eye on each end of the upper roller spindle, to move the upper roller up and down according to the thickness of the feed of the straw or hay.

In addition to these, some other instruments are used in agriculture.

Of these we may mention the corn fan or *fanners*, which every farmer in Scotland and the north of England possesses, and uses for the separating his grain from the chaff. It consists of an oblong wooden box, one end of which is close and somewhat rounded, while the upper half of the other or square end is open. The fans are thin pieces of wood fixed to an axle situated within the box at its rounded end. The axle is turned swiftly by a handle on the outside of the box, and

and the fans produce a brisk breeze or stream of air ^{Instruments} which comes out of the open end of the box. The ^{of Husbandry.} grain is put into a wooden basket at the top of the box. This basket is of the form of a truncated pyramid with its narrow end lowest. The aperture at its bottom is slightly covered by a false bottom, which is made to move to and fro, when the axle is turned on which the fans are placed, and thus lets down the grain gradually in front of the fans. The heavy grain falls across the steam of air produced by the fans, and is received into a measure placed below, through an aperture at the front of the box. The lighter grain is blown towards the open end of the box, and is taken out from time to time. The chaff is blown entirely out of the box.

Carriages of various sorts are also used by farmers; but as these are not peculiar to this, more than to many other branches of business, we account it unnecessary to give a particular description of them. It may be proper, however, to take notice of a most unprofitable practice in many parts of England of using teams or waggons drawn by a great number of horses in farming business. The experience of the most respectable farmers and others, appears now to have demonstrated that the most advantageous mode in which draught horses can be used, consists of employing them in single carts, and that the weight of an additional cart is more than compensated by other circumstances. The following judicious remarks upon the subject have been made by different writers.—“The horses of Cumberland ‡ are not of a large size; one fifteen hands high,

of

~~Instruments of Huban-~~
~~dry.~~ of a light form, that will answer either for riding or drawing, seldom draws less in a single-horse cart than 11 cwt. The common load for a draught horse of that size, is 15 cwt. The carriers from Brompton to Newcastle, over a hilly country, carry frequently 18 cwt. We met a boy 18 years old, a carrier from Longton to Newcastle, driving five carts, in which were four tons, in each cart 16 cwt. A single horse cart carries ten pigs of lead of twelve stone each, which is 11 cwt. It may therefore be fairly concluded, that a common load for a single horse cart will be about 15 bwt.

" In most countries a two-horse cart seldom carries more than 20 cwt; nor a three-horse cart more than 30 cwt. In Cumberland, a boy or girl drives two single-horse carts that carry 30 cwt. Of course two horses yoked in single-horse carts, will draw as much as three horses yoked in one cart.

" A common carrier at Carlisle, who many years employed a waggon, has laid it aside, and now uses single-horse carts only; as he finds he can by that means carry much greater weights.

" The superior goodness of the roads in Cumberland may in a great measure be attributed to the universal use of single-horse carts. Wherever waggons are used they are the destruction of roads, especially in hilly countries where they are obliged to lock the wheels; the banks are in a manner ploughed up with them, and the nine-inch wheels are in reality no more than three-inch wheels, by the artful mode of laying on the middle course of tire. Instead of being nearly exempted from tolls, every horse drawing in a waggon ought to pay treble of what should be exacted from a horse drawing in a single-horse cart. Of what use are waggons except

to destroy the roads? It is clear that the same number of horses yoked in single-horse carts will draw more than when yoked six or eight together. Single-horse carts are easier loaded and unloaded, are much more handy for almost every purpose; and six or eight may be driven by a man and a boy, which is a trifling additional expence. If a middle-sized Cumberland horse draws 15 cwt. a large strong waggon-horse will as easily draw 20 cwt. and which we know is done in some parts of the kingdom.

" Few countries can produce examples of greater draughts by a single horse, on a common road, than Dum-bartonshire. A waggon containing eighty stone of hay, 16 lb. to the stone, each pound containing 23¹/₂ ounces at an average, is an ordinary draught of one horse to Glasgow, &c. at the distance of twelve and fourteen miles. Sometimes the load is 100 stone, which is equal to at least 16 cwt. average. Draughts for a single horse from Leven printfields to Glasgow, at the distance of eighteen or nineteen miles, at one rake, are still greater. The waggon is commonly loaded with goods from 20 to 30 cwt. The same horse generally goes loaded twice a week to Glasgow, and returns loaded. The waggons employed by the printfields are covered, and consequently heavier than common waggons for hay or corn.

" Two-horse carts have gone much into disuse, because two horses in separate carts will carry at least one-third more weight, and with greater ease. Whatever part of the load is before the centre of gravity, which is always in the axle, rests constantly on the horse yoked in the shafts. Going down a hill, this burden must be greatly increased, and always in proportion to the steepness of the descent. But this is not all the evil. Unless the

*Instruments
of Husbandry.* Line of the draught of the foremost horse be always in the line from the hook of his hams to the middle line of the axle, he will be pulling down the other horse's back, or, in other words, will be giving him more weight to carry. The traces are generally fixed about the pin of the teams, which throws the line of the fore horse's draft (behind that pin) a considerable angle above the axle. From which it is plain that the horse in the traces must either not draw at all, or must bring additional weight on the other horses; which is always in proportion to the force with which he draws, and the largeness of the angle which the line of his draught makes with the line betwixt the hook of his hams and the axle of the cart. Besides, unless the driver be more careful than ordinary to keep the trace horse to his duty, the other poor animal has not only this great weight to carry, but all the load to draw. In the long plough with four horses the same reasoning holds (only substituting the muzzle of the plough for the axle of the cart), as far as the drawing is concerned; and even in a plough with two horses, unless the back-ropes are so adjusted that the theats are in a straight line from the hook of the hams to the swingle-tree, the better a horse draws, the more weight he must bring on his back. Skilful farmers indeed say that the weight of the furrow must in some degree rest on the horses necks, by means of the back ropes. This may be a reason for the theats being straight; but not for their being bent upwards."

SECT.

SECT. II.

OF PREPARING LAND FOR CROPPING, BY REMOVING OBSTRUCTIONS AND BRINGING THE SOIL INTO A PROPER STATE.1. *Of removing Stones.*

IT is of the utmost importance to have land effectually cleared of stones, before undertaking any agricultural operation upon it; for by means of them there is frequently more expence incurred in one season, by the breaking of ploughs and the injury suffered by the cattle and harness, than would remove the evil. It has also been observed that the soil round a large stone is commonly the best in the field. It may be considered as purchased at a low rate by removing the stone. At any rate, such stones must be removed before the ground can be properly cultivated: for whether a large stone occupy the surface, or lie beneath it, but within reach of the plough, a considerable space around it cannot be stirred by that instrument, and is therefore useless. Even the rest of the field where stones abound must be laboured in a more slow and tedious manner, on account of the caution necessary to avoid the danger which they produce.

The stones which impede the improvement of land are, 1st, loose stones, or such as are thrown up to the surface by the plough; and, 2dly, sitfast stones, which are either upon or immediately below the surface, but are of such magnitude that they cannot be stirred by

Preparation of Land. The first kind of stones may usually be easily removed by being gathered and carried off.

Modes of removing stones. When land is laid down for hay, such stones are often improperly thrown in heaps into the furrows, where they ever after continue to interrupt the plough, or are dragged again by the harrows over the land. Instead of proceeding in this manner, they ought to be carried wholly off the field in carts at the driest season of the year, and placed in situations in which they may be rendered useful to the farm. In this point of view, stones are sometimes of considerable value for making concealed drains, or for making and repairing the roads through a farm, and also for the repairs of some kinds of fences.

The only writer upon agriculture who has in any case objected to the propriety of clearing land of small stones, is probably Lord Kaines. In some parts of the south of Scotland, and particularly in Galloway, the soil is said to be composed in a great measure of gravel, and of stones of a smooth surface, as if worn by the running of water. After being ploughed, the whole surface of every field appears to be composed of loose stones lying almost in contact with each other. Some industrious farmers, with great labour, collected and removed the stones from a few of their fields, with a view to their improvement ; and the result is said to have been, that the succeeding crops were wholly blighted in the tender blade, and never came to maturity. The stones upon the surface were supposed to have prevented the exhalation of the moisture from the shallow and extremely porous and open soil which they covered : and they were also supposed to have contributed to foster the young plants, by reflecting powerfully from their smooth surfaces

faces the sun's rays in every direction around them : Preparation of Land.
but when they were removed, the soil, in that bleak climate, became at once too cold and too dry for any purpose of agriculture. The farmers, therefore, who had with so much toil and cost removed the stones from part of their lands, could think of no better remedy than, with equal toil, to bring them all back again, and carefully replace them upon their fields. It is added, that the soil immediately resumed its wonted fertility. The truth of this anecdote has never been contested ; and there is no doubt that it has long been current in the south of Scotland, both previous to its publication by Lord Kames, and after that period, among a class of persons who are very unlikely to have been acquainted with his writings. It is possible that the replacing the stones was the best remedy for the want of fertility in the soil which its cultivators had within their reach : but it is probable that they might have found it of more importance to have covered the surface of their land with a substantial coat of clay marl, or even with almost any kind of earth or clay obtained from the bogs and swamps that usually abound in these countries, providing only they could obtain a quantity of lime to add to it. In this way, possessing land whose bottom was very perious to moisture, they might have obtained a soil suited to every purpose of agriculture ; whereas, in its present state, it must remain for ever unfit to be touched by the scythe.

With regard to large or sitfast stones which cannot be removed by any ordinary effort, they usually either appear fully above the surface or are concealed immediately under it. For the sake of discovering concealed stones, it is said to be a custom in Yorkshire,

Preparation when they intend to reduce waste and rude land under
of Land. the plough, in the first place, carefully to go over the whole surface with sharp prongs, which at the distance of every 12 or 14 inches they thrust into the ground to the depth of above a foot, and wherever a stone meets the prong they mark the spot with a twig, a bit of wood, or some other object. They afterwards trace all the marks, and remove every stone before they touch the land with the plough.

Concerning the modes which have been adopted for removing large stones out of the way of the plough; one of the simplest is the following: A pit or hole is dug beside the stone, 16 or 18 inches deeper than the height or thickness of the stone. A number of men are then assembled, who tumble it into the pit. It is immediately covered up with a part of the earth that came out of the hole; and the rest of the earth is scattered over the field, or employed in bringing to a level with the rest of the soil the spot where the stone formerly lay. As the stone now remains at a greater depth than the plough can reach, it is no longer an impediment to agriculture. In performing this operation, however, the workmen must attend to the nature of the soil, and take care that the weight of the stone do not bring down the side of the pit, which might be attended with dangerous consequences. To obviate any hazard of this kind, it is always proper to have at hand a stout plank, which ought to be laid across the pit or hole, immediately under the nearest corner or edge of the stone. With this precaution, a single man may usually perform the whole operation of burying stones or pieces of rock of very great size and weight.

By the above operation, however, the stones are utterly

terly lost; whereas they may sometimes be of considerable value for fences or other buildings. When this ^{Preparation of Land.} is the case, they must be broken to pieces before they are removed. With this view it is to be observed, that a great variety of stones have some thin veins, which being found, wedges can be driven into them by large hammers, so that they may be easily broken. For such operations spades and pick-axes are necessary to clear away the earth, and a large and a small lever to turn the stones out of the ground. Hammers and wedges are also requisite, with carts, to remove the fragments from the field. In the Statistical Account of Scotland, (vol. xix. p. 565. parish of Maderty), we are told that "the Rev. Mr Ramsay, the present incumbent, who occupies a piece of land full of sitfast stones, constructed a machine for the purpose of raising them. It operates on the principles of the pulley and cylinder, or wheel and axis, and has a power as one to 24; it is extremely simple, being a triangle, on two sides of which the cylinder is fixed; it can be easily wrought and carried from place to place by three men. A low four-wheeled machine of a strong construction is made to go under the arms of the triangle, to receive the stone when raised up. This machine has been already of great use in clearing several fields of large stones in this place and neighbourhood."

It is evident, that the machine here described is only valuable for getting stones out of the way in the gross and unbroken; and, accordingly, we learn that stone fences are almost unknown in the parish of Maderty.

Where stones are valuable, therefore, and the operation of breaking them with hammers and wedges is

Preparation found impracticable or too laborious, it will be necessary to blast them with gunpowder. To perform this operation properly, however, considerable experience is requisite; for it is said, that a skilful workman can in most instances, by the depth and position of the bore, contrive to rend stones into three equal pieces without causing their fragments to fly about. In time of war, however, the expence of gunpowder is apt to become very great. With a view to diminish the cost of that article, it has been suggested, that it is proper to perform the operation not with gunpowder alone, but with that article of a good quality, mixed up with about one-third of its bulk of quicklime in fine powder. We are assured that this composition possesses as much force as an equal quantity of pure gunpowder, and it is even alleged, that the proportion of quicklime may be increased with advantage. How the strength of gunpowder should be so much augmented by the addition of quicklime, we do not know. Perhaps it may add to the force of the explosion by undergoing a chemical decomposition of its parts, as it has of late been suspected, that this mineral is by no means a simple or uncompounded body.

Where a field is very greatly overrun with concealed stones, the most effectual method of getting quit of them, and of rendering it permanently arable, consists of trenching it wholly by the spade. Nor is this always the most expensive mode of proceeding. The trenching can be done at the rate of from 3l. to 4l. per acres acre, which is one-sixth larger than an English acre, allowing at the same time the stones or their price at the quarry to the labourers. In this way, the expence of ploughing the field is saved. The soil is deepened

deepened to the utmost extent of which it is capable, <sup>Preparation
of Land.</sup> and can be laid out in the form most convenient for cultivation. In Dr Anderson's report of the state of agriculture in Aberdeenshire, it is said that the expence of trenching an acre to the depth of from 12 to 14 inches, where the stones are not very large and numerous, runs from 4d. to 6d. a fall, which is from 2l. 13s. to 4l. per Scots acre. Ground that has been formerly trenched, is sometimes done as low as 2d. per fall, or 1l. 6s. 6d. per acre. Hence, in consequence of the practice of trenching ground by the spade being not unfrequent in Aberdeenshire, workmen have become expert, and by competition have rendered the price extremely moderate. It is to be wished that the same practice were more frequent in other parts of the country, as it would have a tendency to introduce a taste for the most correct and perfect of all modes of labouring the soil, and would also occupy a considerable part of the population of the country, in the most innocent and healthful of all employments, that of agriculture.

2. *Of Draining.*

It has already been remarked, that the presence of moisture is of the utmost importance to the success ^{of draining,} of vegetation. At the same time, as must necessarily happen with every powerful and active agent, the too great abundance of water is no less pernicious to many plants, than an entire want of it. When it stagnates upon the soil, it decomposes or rots the roots and stems of the most valuable vegetables. Even when it does not remain on a spot round the whole year, its temporary stagnation during the winter renders the land unproductive. Ses-

Preparations of tillage are often lost, and in wet years the crop of Land must always be scanty and precarious. When in grass, the land can only produce the coarsest and most hardy vegetables, which can resist the chill or cold state of the soil, or the fermentation which is often produced by sudden warmth while the water remains upon the ground. Hence arises the importance of draining, by which arable land is rendered manageable, is made to dry gradually and early in the spring, and the corn is increased in quantity and weight; and by which, in pasture lands, the grasses are made to change their colour and to lose their coarse appearance, and the finer kinds of plants are enabled to flourish. Even the climate is, by means of draining, very considerably improved. It is rendered less cold during the winter, and by diminishing in hot weather the exhalations from the soil, its salubrity both to animal and vegetable life is greatly increased. Every kind of grain comes earlier to maturity. The harvest is less precarious, and the diseases are banished which arose from a damp soil and a humid atmosphere.

Land is rendered wet by rain or by springs. The water which stagnates upon the surface of a soil may originate from two causes. It may descend upon it in the form of rain, or it may ascend from springs or reservoirs of water in the bowels of the earth. The rules for draining land which is rendered too wet for the purpose of agriculture are different, according to the causes which occasion the wetness. We shall first take notice of the most approved modes of draining, when the excessive moisture is occasioned by rain or surface water stagnating upon the land; we shall afterwards state the plan of draining to be adopted, when the wetness arises from springs or water arising out of the earth; and

and, lastly, we shall give an account of the mode of Preparation of Land. draining what are called landlocked bogs, from their being situated upon a lower level than the adjacent country.

§ 1. *Of Draining Lands rendered wet by the stagnation of rain water upon their surface.*

To relieve land from rain water that is apt to stagnate upon it, two kinds of drains have been adopted. Drains are open or hollow. Of these, some are called *open drains*, from their being exposed to view in their whole length. The other kind receives the appellation of *hollow drains*, from their being covered, so that their existence is not apparent to a stranger, nor is any part of the land lost in consequence of their being made. Hollow draining is sometimes avoided on account of the great immediate expense with which it is attended, and in some situations it is altogether inadequate to the object in view. There are some soils that being chiefly composed of a stiff clay, possess so great a degree of tenacity as to retain water upon every trifling depression of their surface, till evaporation carries it off. It is in vain to attempt to drain such soils by hollow channels below ground, as the water will never be able to filtrate through the soil so as to reach the drain. In such situations, therefore, open draining is the only mode that can be adopted for clearing the soil of surface water.

It also sometimes happens that on ordinary soils, hollow drains would speedily be rendered useless. This must take place where the admission of surface water cannot be avoided, and, from the figure of the adjoining lands, must be very greatly augmented in time of heavy rains. In such cases, a close or hollow drain

~~Preparation~~ drain would speedily be choked up by the sand, and
~~of Land.~~ soil brought down by sudden and violent torrents. In these situations, therefore, open drains can alone prove useful.

~~Draining of clay soils.~~ Soils formed of a tenacious clay can only be drained by being laid up properly in ridges which are high in the middle, and have furrows at each side for carrying off the water. The great art of preserving land of this description, therefore, free from superfluous moisture, consists of laying out every field in such a direction as that all the furrows between the ridges may have a gradual descent to a common ditch or drain for carrying off the water. Where at any particular spot the regularity of the descent is interrupted, cross furrows must be kept open with the same view. The ridges must also be laid up in such a form as to allow the water to descend from the summit in the middle to the furrows on each side. If the ridges, however, are too high in the centre, there will be a danger that in heavy rains the soil may be washed from the summit down into the furrows, which would produce the double evil of impoverishing the centre of every ridge, and of choking up the furrows, and rendering them unfit to drain the land.

The distinguished success of the Flemish husbandmen, and also of the farmers in the central countries of England where this kind of soil abounds, sufficiently demonstrates the practicability of preserving it in a due degree of dryness for the most valuable purposes of agriculture. In these English counties, and in Flanders, the general mode of drying land consists of ploughing it up in high and broad ridges, from 20 to 30, ~~and~~ even 40 feet wide, with the centre or crown three ~~or~~ four

four feet higher than the furrows. By attentively preparing the furrows in good order, and free from stagnating water, the land is kept in a dry state, and all kinds of crops flourish.

The mode of ridging and cross-furrowing the clay soil of the Carse of Gowrie, Perthshire, has been thus described by George Paterson, Esq. of Castlehunty in that county. "There are certain large common drains which pass through the district in different directions, sufficiently capacious to receive the water drained from the fields by the ditches which surround them, and of such a level as to carry it clear off, and to empty their contents into the river Tay. There are also ditches which surround every farm, or pass through them as their situation may require, but in such manner as to communicate with every field upon the farm. These ditches are made from two to four feet wide at top, and from one and a half to one foot at bottom; a shape which prevents their sides from falling in: but even then they must be cleansed and scoured every year at a considerable expence. If the fields be of an uniform level surface, the common furrows between the ridges, provided they be sufficiently deepened at their extremities, will serve to lay the grounds dry; but, as it seldom happens that any field is so completely free of inequalities, the last operation, after it is sown and harrowed in, is to draw a furrow with the plough through every hollow in the field which lies in such a direction that it can be guided through them, so as to make a free communication with any of the ditches which surround the farm, or with any of the furrows between the ridges, which may serve as a conductor to carry the water off to the surrounding ditches. When this track is once opened

Preparation opened with the plough, it is widened, cleared ~~out~~,
~~of Land.~~ and so shaped with the spade, that it may run no risk
of filling up. Its width is from six inches to a foot, ac-
cording to its depth, which must depend upon the level
of the field; but the breadth of a spade at bottom is a
good general rule. It frequently happens that there
are inequalities in several parts of the same field, which
do not extend across it, or which do not pass through
it in any direction that a plough can follow; but which
may extend over two ridges, or one ridge, or even part
of a ridge. Such require an open communication to
be made with any furrow, which may serve as a con-
ductor to carry off the water, which is always made
with the spade. All these open communications are
here called *gaas*, and to keep them perfectly clear is
a very essential object of every Carse farmer's atten-
tion."

"It is the general practice in the Carse to have head-
ridges, as they are called, at the two extremities of
each field; that is, the ground upon which the plough
turns, is laid up as a cross ridge, higher in the middle
and falling off at each side, so that a gaa is made in the
course of the inner furrow, with which the whole fur-
rows between the longitudinal ridges communicate,
and into which they pour all their surface water,
which is carried off by gaas or openings cut through
the head ridges, and emptied into the adjoining
ditches which convey the water to the main drain.
Besides all this, an experienced Carse farmer takes care
that his lands be carefully ploughed, and laid up equal-
ly without inequalities that can hold water, and that
the ridges be gradually rounded, so that the surface
water

water may neither lodge nor run so rapidly off as to injure the equal fertility of the field." Preparation
of Land.

With regard to the general rule for making open drains, it may be observed, that their depth and width must always in some measure be left to the judgment of each particular husbandman, that they may be varied according to the variety of soils and situations. Upon the whole, however, the width at bottom ought to be one-third of that at top, that, by being sufficiently sloped, the sides may be in no danger of falling in. The fall or declivity also should be such as may carry off the water, without stagnation, and along with it any grass and other loose and light substances that may get into the ditch. At the same time, care ought to be taken to lead the drain in such a direction down any steep declivity that may occur in an oblique manner, that the water may not have too rapid a motion, as it would otherwise be apt to form inequalities in the bottom, and to wear down the sides. In mossy and very soft soils drains require to be of considerable width, on account of their tendency to fill up; and their breadth at top must exceed that at the bottom in a greater degree than the proportion already mentioned. In all cases in which a ditch is intended for a drain only, and not to be used as a fence, none of the earth thrown out of it ought to be allowed to remain upon the sides, but should be spread abroad upon the land, or used in filling up the nearest holes. When this is not done, the utility of the drain is injured by the surface water being prevented from reaching it, and by the tendency which this weight of earth has to cause the sides to fall in; the difficulty of scouring or cleaning it is thus also much increased. If it be necessary, however, to

use

Preparation use the ditch, and the earth thrown out of it, as a fence, of Land. a deep furrow ought to be made along the back of the mound of earth, with openings in convenient places into the ditch for transmitting to it the water collected in the furrow.

In plantations, open drains are the only kind that can be used, as the roots of the trees would be apt to choke up covered drains. In pastures, small and narrow open cuts, made with the plough or otherwise, are often extremely useful, to carry off stagnating water and a part of the rain as it falls. The only objection to them is, that they are easily stopt by the trampling of the cattle ; but, on the other hand, they are easily restored. Concerning all open drains, indeed, it must be remembered, that they require to be cleaned out at least once a-year ; and when this process is neglected for any length of time, it becomes more difficult, and the drains lose their effect. Hence, though open drains are originally cheaper, yet, by the necessity of annual repairs, they sometimes become ultimately more expensive than covered or hollow drains, to the consideration of which we shall next proceed.

Nature and history of hollow drains. Hollow drains, in which the water is allowed to flow along a bed of loose stones, or other porous materials that are covered with a bed of earth in which the operations of the plough can proceed, bear a near resemblance to that part of the constitution of nature by which water flows in various channels along beds of porous strata in the bowels of the earth, and coming to the surface in various situations, supplies springs and the constant flow of rivulets and of the largest streams. The practice of hollow draining was known in a very remote antiquity. It is said that the present Persians,

as formerly mentioned, are supplied by means of hollow drains with water in their most fertile fields, though they know not from whence the water is brought, and are unacquainted with the arts by which a more ingenious people, in former times, contrived to deprive one part of the soil of its superfluous moisture with a view to enrich another. The ancient Roman writers, Cato, Palladius, Columella, and Pliny, particularly mention the practice of hollow draining. They knew the kind of soils in which these drains are useful, and the propriety of directing them obliquely across the slope of the field. They filled them half way up with small stones, and for want of these with willow poles, or even with any coarse twigs or other similar materials twisted into a rope. They also fortified the heads of their drains with large stones, and their mouths or outlets with a regular building; and they carried the whole drain to the depth of three or four feet.

As already mentioned, hollow drains are of little use in a soil that consists of a stiff clay, and are chiefly useful where, from whatever cause the wetness may result, the soil is sufficiently porous to allow the moisture to percolate to an internal drain.

If the field proposed to be drained lie on a declivity, great care should be taken to make hollow drains in a direction sufficiently horizontal to prevent a too rapid fall of the water, which might wear the bottom uneven, and have the effect to choke, or, as it is sometimes called, to *blow up* the drain, whereby in certain spots in the field artificial springs would be formed.

Concerning the season for executing drains, discordant opinions are entertained. Some prefer winter, others summer. Where much work is to be accomplished,

Preparation accomplished, a choice of seasons may not indeed be left of Land. to the husbandman. Some farmers, however, when they have the choice of time, always prefer summer for this employment, being then able to execute the cuts in a neater manner without that kneading of the soil which takes place in winter, which they think hurts the usefulness of the drain, by ever after preventing the water from easily finding its way to it; besides, that it is easier to bring the stones or other materials to the spot in summer than in winter. Others, however, prefer draining in winter, because in the case of a clay soil the labour is at that season much easier; and also because labourers are then usually most easy to be obtained.

The depth and width usually adopted for hollow draining is very various, according to the nature of the soil and the situation of the field. When the practice first came into general use, three feet is said to have been the common depth; but, for many years past, it is said that hollow drains seldom exceed 30 or 32 inches, and that more drains are of two feet, or 26 inches deep, than of any other. One general rule, however, cannot be neglected with safety, that the depth must be sufficient to prevent the materials with which the drain is filled from being affected by the feet of horses in a furrow while ploughing; twenty-four inches is perhaps too little for this purpose. A horse's foot in a furrow is usually at the depth of four inches or more. If ten inches additional be allowed for the materials employed in filling the drain, there will remain only nine or ten inches to support the foot of a horse exerting his strength in the act of ploughing, which upon a porous soil seems scarcely sufficient.

What are called *main drains*, which are those intended to receive the water of several other drains, must always be somewhat deeper than the rest, having more water to convey. As to the wideness of hollow drains, most farmers have of late been solicitous to render them as narrow as possible, because by this means a great saving takes place of the materials used for filling them. If the stones are coupled at the bottom of the drain, that is, made to lean towards each other, so as to constitute a triangle, of which the bottom of the drain forms the base, the width need not be greater than one foot; nor perhaps is it even necessary to exceed this breadth where large stones are thrown in promiscuously. That the ditches or cuts which are meant to be converted into hollow drains may be executed with neatness and care, a point of much importance to their usefulness, it is thought prudent that the workmen should not be paid according to the extent of ground which they open, but as day labourers. This, however, is more particularly the case with regard to filling the drains, an operation in which a still greater degree of attention is necessary.

The materials used for filling drains have been various, according to the substances which different farmers have been able to obtain. Stones, however, are the most common, and also the best of all materials, on account of their permanency. If stones from quarries are to be used, and the drain formed like conduit at the bottom, the trench must be made at the lowest part 16 inches wide, containing two side stones about six inches asunder, and the same in height, with a cap or flat stone laid over, which secures the cavity. Such hollow drains are commonly used for permanent currents with which hollow drains may be filled.

Preparation rents of water from springs, and are more expensive of Land. than where no such steady current exists, and the stones are either thrown in promiscuously, or laid down so as to form triangular cavities. Small stones, however, ought not to be used for the bottom of a drain. Whether the stones are large or small, they ought to be very clean, having no clay or earth adhering to them, and of the most hard and permanent quality that can be procured, with as little tendency as possible to moulder or decay in consequence of alternate changes from wet to dry. They ought also to be laid in carefully, so as not to tumble down any earth, which might choke up their interstices. The whole subject, however, will be better understood by a statement of the way in which drains have been filled with success by intelligent persons.

The following directions are given by T. B. Bayley, Esq. of Hope, near Manchester: "First make the main drains down the slope or fall of the field. When the land is very wet, or has not much fall, there should in general be two of these to a statute acre; for the shorter the narrow drains are, the less liable they will be to accidents. The width of the trench for the main drains should be 30 inches at top, but the width at the bottom must be regulated by the nature and size of the materials intended to be used. If the drain is to be made of bricks, 10 inches long, 3 inches thick, and 4 inches in breadth, then the bottom of the drain must be 12 inches; but if the common sale bricks are used, then the bottom must be proportionably contracted. In both cases there must be an interstice of one inch between the bottom brick and the sides of the trench, and the vacuity must be filled up with straw, rushes, or loose

loose mould. For the purpose of making these drains, Preparation
I order my bricks to be moulded 10 inches long, 4 of Land.
broad, and 3 thick; which dimensions always make the
best drain."

The method which this gentleman pursues in constructing his main drains is stated by him to be the following: When the ground is soft and spongy, the bottom of the drain is laid with bricks placed across. On these, on each side, two bricks are laid flat, one upon the other, forming a drain six inches high, and four broad, which is covered with bricks laid flat.—When the bottom of the trench is found to be a firm and solid body, such as clay or marl, he formerly thought that it might not be necessary to lay the bottom with brick; but in this he has candidly acknowledged that he was quite wrong. By the runs of water, the alternate changes from wet to dry, and the access of air, these hard bottoms were rendered friable, crumbled away, and let in all the drains, and allowed them to choke up, that were not supported by a bottom laid with brick or stone. When stones are used instead of bricks, Mr Bayley thinks that the bottom of the drain should be about eight inches in width; and in all cases the bottom of main drains ought to be sunk four inches below the level of the narrow ones, whose contents they receive, even at the point where the latter fall into them.

The main drains should be kept open or uncovered till the narrow ones are begun from them, after which they may be finished; but before the earth is returned upon the stones or bricks, it is advisable to throw in straw, rushes, or brushwood, to increase the freedom of the drain. The small narrow drains should be cut

Preparation at the distance of 16 or 18 feet from each other, and of Land. should fall into the main drain at very acute angles, to prevent any stoppage. At the point where they fall in, and 8 or 10 inches above it, they should be made firm with brick or stone. These drains should be 18 inches wide at the top, and 16 at bottom.

A mode of draining clay soils wet by rain or surface water, practised by Sir Henry Fletcher, Bart. with great success, seems worthy of being here stated. The upper soil is of good quality; but being situated in a mountainous part of the country, the frequent rains kept the upper soil so full of water, that it produced only a coarse grass worth 3s. per acre. The inferior soil of clay was of great depth. The mode of draining which has been successfully practised upon it is the following: "On grass lands he digs 22 inches, or 2 feet deep; the first spadeful is of the turf, taken so deep, as where it separates from the clay, which is dug carefully out, and preserved unbroken grass side up, and laid on one side of the cut; then, with a very strong spade, 18 inches long, 6 inches wide at top, and 2 at the bottom, he digs a spadeful in the clay, which the men spread about the land, on the side of the drain opposite to where the turfs were laid, as far as possible from the drain, so as none may get in again. A scoop, to clear out the fragments in the bottom, follows, which are also spread in like manner. They are then ready for filling; and in doing this, he takes three stones of a thin flat form, two of which are placed against the sides of the drain, meeting at bottom; and the third caps the other two. Thus, a hollow triangular space is left to convey the water, which is subject to no accidents that can fill it up or impede the current.

current. Stones always sink deeper in the ground ; and Preparation
in the common method, this frequently causes stoppings by their being partly buried in the clay : but the Land.
triangle, when it subsides, does it regularly, and keeps its form and the passage for the water clear. One cart-load of stones, in this way, will do a considerable length of drain. They are carefully laid down by the side of the cut, with a shovel or basket, and if there are any small refuse stones left on the ground after the drain is set, they are thrown in above. The stones being thus fixed, the sods are then trimmed to the shape of the drain, and laid on them with the grass side downwards, and none of the clay used in filling up.

The expence is a halfpenny per yard, the men earning 2s. and 2s. 6d. per day, at 10 yards distance from drain to drain. At 6 yards distance they answered well, but would not operate a cure, if more than 7 yards asunder. At this last distance, therefore, the expence of draining an English acre, at ½d. per yard, would amount to 1l. 9s. 2d. the stones being not more than half a mile distant.

Not only stones and bricks, but also wood and other materials have been used for filling drains. Upon this point, Lord Petre expresses himself thus : "The drains filled with wood, and covered as usual with straw or rushes, are preferable to stones or any other kind of materials ; the reason is, as the wood decays, the water continues to pass. When filled with stones, and the drains stop up, which must be expected to take place in time, the earth becomes quite solid round the stones, and as they do not decay, the filtering of the water is for ever obstructed : not so when bushes or wood are

Preparation used ; continual filtering and draining are then for ever of Land to be perceived ; and by repeating the operation a second time, cutting the drains transversely of the old ones, the benefit of the filterings through the rotten wood is secured, and the spewing up of old, broken, and damaged drains corrected and carried off. Moreover, as bushes form a much greater number of cavities than either stones or poles, they are less liable to stop up, and encourage filtering more than larger and more solid bodies. A load of bushes containing 120 faggots, will do about 360 rods ; and a load of straw containing 120 bottles, the same : the load of bushes is generally worth about 14s. and the straw 18s. per load. I therefore calculate this expence about 12s. per acre, ditches a rod apart."

Richard Preston, Esq. of Blackmore, prefers, on twenty years experience, black thorns to every other material for filling drains. Wood is sometimes used with this view, in the following manner : Two billets are placed at opposite sides of the drain, and each is made to rest upon the opposite side to that on which its lower part stands, so as to form with each other a St Andrew's cross. The upper part of the cross is filled with brushwood, laid longitudinally, above which straw is placed cross-ways, and the mould is thrown in over all. This kind of drain is said to have continued running in Berwickshire for 30 years, and it is recommended by the author of the Agricultural Report of the county of Caermarthen, in Wales. He says, " The completest method I have yet known, is to cut the strongest willows, or other aquatic brushwood, into lengths of about 20 inches, and place them alternately in the drain, with one end against one side of the bottom,

tom, and the other leaning against the opposite side. Preparation of Land.
Having placed the strong wood in this manner, I fill the space left between them on the upper side with the small brushwood, upon which a few rushes or straw being laid, as before mentioned, the work is done. Willow, alder, asp, or beech boughs, are exceedingly durable if put into the drain green, or before the sap is dried; but if they are suffered to become dry, and then laid under ground, a rapid decay is the consequence. I have seen willow taken out of a bog, after lying there thirty years, and its bark was as fresh and fappy as if it had been recently cut from the hedge; and it is well known that beech laid green in the water will continue sound for any length of time."

Another method of using wood consists of fixing at every foot distance in the drain, a stick in the form of a semicircular arch, and of laying upon these longer branches or twigs longitudinally. Thus is a curved cavity, or arch, formed beneath, capable of supporting any weight of earth. For this purpose young wood is recommended, and in particular the prunings of larch.

Instead of wood or stone, in many places, it has of late become customary to fill the lowest part of drains with straw, and with that view to make use of wheat stubble as the cheapest kind of straw. On this subject, Mr Vancouver, in his Report of the Essex husbandry, remarks, that when the soil is a very close and retentive clay, the drains should be made proportionally near to each other, shallow, and filled with straw only, it being totally unnecessary to use wood or any more durable material upon land where the sides of the drains are not likely to crumble in. He asserts that drains

Preparation of Land. formed in this manner, through the tough and retentive clays, will be found in a short time after the work is finished, to afford over the straw, with which the drain was filled, an arch of sufficient strength to support the incumbent weight of the soil, and the casual traffic of the field. "In 12 or 18 months it may be observed that the straw, being of one uniform substance, is all rotted, and carried away, leaving a clear pipe through the land in every drain, into which the passage of the water may have been much facilitated, by a due attention to the filling of the drains with the most friable and porous parts of the surface the field might have afforded."

An improvement in filling hollow drains with straw, consists of twisting the straw into a rope, said to have been devised by Mr Bedwell, of Essex. The rope of straw is formed as large as a man's arm, and is placed at the bottom of the drain. The expence of draining an English acre of land with this material in Essex, is said to stand thus :

For cutting and raking together an acre of wheat stubble, generally sufficient for an acre of drains,	- - -	L. 0 2 0
Digging eight score rods of drains,		0 13 4
Filling them up with stubble,	-	0 2 8
Extra work with the common spade, on an average a day's work for a man,	-	0 1 4
		L. 0 19 4

As in some situations it is an object of great importance to save the expence of materials commonly used in filling drains, a variety of devices have with that view been

been adopted. One of these is of the following nature. Preparation of Land.
A drain is first dug to the necessary depth, narrow at bottom. Into the trench is laid a smooth tree, or cylindrical piece of wood, 12 feet long, 6 inches diameter at the one end, and 5 at the other, having a ring fastened into the thickest end. After strewing a little sand upon the upper side of the tree, the clay or toughest part of the contents of the trench is first thrown in upon it, and thereafter the remainder of the earth is fully trod down. By means of a rope through the ring the tree is then drawn out to within a foot or two of the smaller or hinder end, and the same operation is repeated till the whole drain is complete. Such a drain is said to have conducted a small run of water a considerable way under ground for more than 20 years without any sign of failure.

What is called the sod or pipe drain consists of a Sod or pipe trench dug to a proper depth; after which a last spade-drains. ful is taken out in such a way as to leave a narrow channel, which can be covered by a sod or turf dug in grass land and laid over it, the grass side downwards. Such drains are said to continue hollow, and to discharge well for a great number of years. Mosses are said to be drained in Lancashire nearly in the same manner, by leaving shoulders about a foot and a half from the bottom of the trench, and laying across these pieces of dried peat or turf, cut into lengths of 16 inches, and 8 or 9 inches in breadth.

In Buckinghamshire, in grass lands, the sod drain is thus made: When the line of drain is marked out, a sod in form of a wedge is cut, the grass side being the narrowest, and the sods being from 12 to 18 inches in length. The drain is then cut to the depth required, but

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contracted to a very narrow bottom. The sods are then set in with the grass side downwards, and pressed as far as they will go. As the figure of the drain does not suffer them to go to the bottom, a cavity is left, which serves as a water course; and the space above is filled with the earth thrown out.

Another invention for draining land is described in the agricultural report of the county of Essex. It consists of a draining wheel of cast iron, that weighs about 4 cwt. It is 4 feet in diameter, the cutting edge or extremity of the circumference of the wheel is half an inch thick, and it increases in thickness towards the centre. At 15 inches deep it will cut a drain, one half of an inch wide at the bottom, and 4 inches wide at the top. The wheel is so placed in a frame, that it may be loaded at pleasure, and made to operate to a greater or less depth, according to the resistance made by the ground. It is used, in winter, when the soil is soft; and the wheel tracks are either immediately filled with straw ropes and lightly covered over with earth, or they are left to crack wider and deeper till the ensuing summer; after which the fissures are filled with ropes of straw or of twisted twigs, and lightly covered with the most porous earth that is at hand. Thus, upon grass or ley lands, hollow drains are formed at a trifling expence, which answer extremely well. It is said that 12 acres may be fully gone over with this draining wheel in one day, so as to make cuts at all necessary distances.

On sheep pastures a still simpler mode of removing surface water is said to be practised in some places. Wherever the water is apt to stagnate, a deep furrow is turned up with a stout plough. Thereafter, a man with

with a spade pares off the loose soil from the inverted Preparation of Land. sod, and scatters it over the field, or casts it into hollow places. The sod thus pared and rendered thin, or brought to the thickness of about three inches, is restored to its original situation, with the grassy side uppermost, as if no furrow had been made. A pipe or opening is thus formed beneath it two or three inches deep in the bottom of the furrow, which is sufficient to discharge a considerable quantity of surface water which readily sinks into it. These furrows, indeed, are easily choked up by any pressure, or by the growth of the roots of the grass; but they are also easily restored, and no surface is lost by means of them.

With regard to the duration of hollow drains, or Duration of the length of time that the water will continue to flow in them, and thereby to preserve the soil in a proper state of dryness, it must necessarily depend, in a great degree, upon the nature of the materials with which they are filled, and the care that has been taken to prevent their being choked up by any accession of soft soil. Independent of this last circumstance, a drain filled with stones, like the channel which supplies a natural spring, may endure for ever. Wood, with which many drains have of late years been filled, perishes at certain periods according to its nature; but it does by no means follow, that the drain should lose its effect in consequence of the destruction of the wood. If the earth over it form itself into an arch, the water will still continue to flow. Accordingly, it is said, that drains filled with bushes and straw have been known to run well after 40 years.

§ 2



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Preparation
of Land.

Drains
when the
soil is
wet by
springs.

§ 2. Of Draining Lands rendered wet by springs.

Having thus stated the various modes that have been most successfully adopted for draining lands of a super-abundant moisture caused by rain or surface water, we shall proceed to consider the way in which a soil may usually be drained when its undue wetness is the consequence of natural springs, or of water arising out of the bowels of the earth.

Nature of
springs.

To understand the principles upon which land, rendered wet by springs, may be drained for the purposes of agriculture, it is necessary to attend to the materials of which the globe we inhabit is composed, and to the manner in which large quantities of water find their way into its bowels. The earth upon which we tread is by no means an uniform mass of matter. It consists of various layers or strata of different substances, one placed over the other. These layers or strata are seldom situated horizontally, but almost always descend towards one side or the other. One part of a stratum or layer often ascends and appears on the surface, while the other end or side of it descends obliquely to a great depth into the earth. Having done so, it frequently again bends upwards towards the surface; and indeed assumes almost all the variety of irregular forms and bearings that the imagination can conceive; sometimes suddenly breaking off and giving place to other strata or layers, and sometimes continuing at one corner while the greater part of it ceases. These strata or layers, of which the earth is composed, may be considered, with a view to the explanation of our present subject, as of two kinds. Some of them are porous, and allow water to pass through their substance, and to

fill

fill up all their cavities and interstices, such as sand, Preparation
gravel, some marls, and various kinds of porous rocks. of Land.
Other layers, on the contrary, do not suffer water to enter into them; such as clay, or gravel with much clay mixed with it, and rocks of a close and compact nature, without any fissures or clefts in them.

It is next to be remarked, that it is chiefly upon high mountains that water exists, or is formed, in very great abundance. Not only do the mountains catch and break the passing clouds, which deposit upon them the greatest portion of their watery contents, but they would seem to have a power, when neither rain nor clouds appear in the sky, of condensing, attracting, or somehow forming water from the atmosphere. In the great burning deserts of Africa rain is scarcely known. The inhabitants build their houses of clods of earth or of lumps of salt. A drizzling shower, which is apt to come once in several years, endangers every dwelling; and two hours heavy rain would lay a whole city in ruins; yet even there, wherever mountains exist, that is to say, naked rocks which abound in a few districts of this wilderness, water is almost always found in their vicinity; and, in consequence of the water, spots covered with the most luxuriant verdure are seen like islands amidst the dreary tracts of moveable and unproductive sand.

The upper part of mountains is very frequently covered with a layer of gravel, or loose and open rock, into which water readily penetrates. These porous layers or strata descend gradually into the bowels of the earth, and convey along with them the water which they contain, and have received from the clouds. Under the porous stratum or layer of gravel are usual-

ly

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rationally layers of clay or of solid rock, through which the water cannot pass, but along the upper part of which it flows. After descending, however, a certain length obliquely down towards the plain country, the layers of porous gravel usually pass under new layers or strata of clay and other impervious materials. Thus, as the water in the stream is confined between clay above and gravel below, and must descend along the gravel, which is pervious to it, streams of water are formed in the bowels of the earth, which have their outlets in high gravelly soils, and their outlets at any place in the low country, where any part of the beds of gravel or porous rock, along which they flow, happens to approach the surface, forming springs and rivulets, and, by their union or conflux, mighty rivers, which continue steadily to water the surface of the earth. Hence also, in very many situations, by digging pits into the earth, we at last reach a layer of porous gravel or rock, containing a stream of water brought, perhaps, from the summit of a distant mountain; and such pits can be used as wells for supplying water for every domestic purpose.

We have said that the upper part of the face of a mountain is often covered with a bed of porous or gravelly substances capable of taking in water. Upon the surface, at a certain distance down the hill, a bed of clay begins. The water received above into the layer of gravel continues to descend with that layer for a considerable space below the bed of clay; and thereafter the gravel suddenly stops, and the clay above unites with the clay beneath, or with some other impervious strata upon which the gravel all the way rested. In this situation, as the water contained in the

gravel can proceed no farther, it hangs within the side Preparation of Land. of the hill as in a bag of clay ; and a reservoir is formed of water within the earth. When this bag or natural reservoir is full, the water contained in it is pressed upwards against the clay by which it is covered. It moistens this clay, and finds its way by chinks through all its weaker parts or pores. Thus a belt of soft and spouty land is formed upon the side of the hill ; the mode of draining which is very easy. If a hole is dug into the earth near the bottom of the bag or reservoir of water, so as to reach the layer of gravel, the water will instantly flow freely out, and, being no longer restrained, it will cease to press upon the layer or stratum of clay that covers it, or to force a passage through its chinks ; and the soil will consequently be drained.

Let it be supposed, that the porous stratum or layer of gravel, instead of stopping on the side of a hill, descends into a plain or level country, the water all the while passing along in its bowels ; and that the gravel has a layer of clay below and another layer of clay above it. After it has reached and passed to a considerable distance along the valley, if the layer of gravel either suddenly stop and allow the layers of clay to come together, or if the gravel have too little thickness and capacity to allow the water which flows within it to pass easily along, it will necessarily, from the new supplies of water which are continually descending, be pressed upwards against the layer of clay which covers it : as, in the former case, the clay will be softened, and the water will filtrate through all its weaker parts till it reach the surface, which it will keep constantly wet, and where it will stagnate in consequence

Preparation sequence of the flat and level form of the country.
of Land.

Over the softest places, a coarse verdure will spread, and the roots of the plants intertwining, will form shaking quagmires. In other places, the moss plants, being the only ones which can thrive in the moist and ungenial soil which is thus produced, will rapidly spring up, and a moss will be formed altogether unfit for any purpose of agriculture. To drain such a soil, it is evidently only necessary to dig a pit or hole through the upper stratum of clay into the gravel, to give a free vent or issue to the water; which having thus found an easy passage to the open air, will cease to press upon the incumbent layer of clay, or to render it moist. This clay will therefore speedily become dry and collapse; the moss plants will wither, provided the surface is properly drained; and the whole soil will become solid and fit to be cultivated.

It sometimes happens, as already noticed, that a piece of territory which lies low is rendered extremely wet by rain and spring water coming from adjacent high grounds, and lodging upon its surface, while, at the same time, it is so completely surrounded by eminences, or land-locked, that it cannot be drained at a moderate cost; the consequence of which is, that the water stagnates, and a moss or bog is formed. The practical mode of draining such a bog will be afterwards explained. In the mean time it may be remarked in passing, that the principles which we have already stated concerning the manner in which the globe is made up of various strata, indicate the way in which such a bog may be drained at a cheap rate. It is only necessary to dig a pit at the lowest part of it, down through the clay, or other impervious layer that holds up the water, till a porous stratum

stratum is reached capable of conveying away the surface water down the country below ground to the sea, or to such rivers as it may chance to be connected with.

The whole art of draining land where the wetness is occasioned by water pressing upwards from the bowels of the earth, depends upon these principles. It is an art whose importance is not yet sufficiently appreciated, because imperfectly understood, and because it has not yet been carried in practice to its full extent. It is probable, however, that at no remote period it will be held in universal estimation, on account of the command of those hidden streams that are contained in the bowels of the earth, which it will give to mankind for the purposes of an improved agriculture, and for the service of commerce in filling canals and giving motion to every kind of machinery. A dispute exists about the original discovery of this art. The celebrated writer upon agriculture, Dr James Anderson of Aberdeen, in his "Essays on Agriculture and Rural Affairs," published in 1775, was undoubtedly the first person who explained to the world the nature of the art of draining land rendered wet by springs, and the principles upon which it ought to proceed; having been led to the investigation many years before, by his having fortunately succeeded in draining a bog by sinking a pit in it through the clay till an opening was made into the gravel or porous stratum, from which the water rushed up vehemently. In the mean while, it had happened that Mr Joseph Elkington, possessor of a farm in England called Prince-thorp, in the parish of Stretton upon Dunsmore, and county of Warwick, almost as early as Dr Anderson, had accidentally discovered that land might be drained in many situations by making a small hole into the earth.

Preparation Being a man of considerable natural ingenuity, though, of Land. it is said, of little literature, he had the address to take advantage of the discovery he had made, with a view to the improvement of his affairs. He therefore commenced the trade of a drainer of land; and by the novelty of draining land by a small hole bored often at a considerable distance from the wettest part of it, and by conducting himself in a mysterious manner, he acquired great reputation, and was extensively employed. This employment he appears to have merited, as his operations were attended with very great success. After the establishment of the Board of Agriculture, its members, who appear to have been unacquainted with Dr Anderson's publication, supposed Mr Elkington to be the only discoverer and possessor of the art of draining land wet by springs in the way now mentioned; and upon their recommendation, parliament bestowed a reward of 1000l. upon him. It was surely an unfortunate circumstance, that the first premium granted upon the recommendation of this board, should have proceeded upon a error, as it undoubtedly did; for although Mr Elkington had the merit of being the first who introduced this art extensively into practice, there is no doubt that Dr Anderson, by whom also it was discovered, was the first who explained its principles to the public, and that at a period when Mr Elkington's secret remained with himself. After all, however, it is not to be supposed that the theory of this art was absolutely unknown, although these persons appear to have been the first who proposed to apply it extensively to the purposes of agriculture. It is said that the practice is very ancient in Italy, when a well is dug, to avoid the expence of going to a great depth, by boring

ing with an auger in the bottom of the pit, in the Preparation of Land. hope of reaching the porous stratum which contains the water. And in Germany it appears, as will be afterwards noticed, that the practice has long existed of draining land-locked bogs, by letting down the water by means of a pit through the impervious clay, to a porous substratum.

We shall now proceed to state the most approved practical modes of draining land that is rendered wet by springs, or water ascending out of the earth ; and as the Board of Agriculture instructed Mr John Johnston, land surveyor, to inspect Mr Elkington's principal drainings of this sort, and to give an account of them, we shall give all due attention to the contents of the report made out by that gentleman, which is understood to have been executed with much fidelity and accuracy ; though we shall also exhibit, at the same time, the practice of other intelligent persons upon the same subject.

In the practice of this art it will readily occur, that it is of the utmost importance to obtain a knowledge of the internal structure of the earth, and of the manner in which its various layers or strata succeed, and are usually intermingled with each other. This object, however, can only be attained in any considerable degree of perfection by observation and experience. There are several ways, however, by which a man of sagacity and reflection may greatly abridge the difficulty of this study, so as in a short time to enable himself to practice the art of draining with considerable success. The surest way of ascertaining the inclination of the different strata, or the way in which they lie upon each other and the direction in which

Preparation they descend into the earth, consists of examining the bed of the nearest rivers, and the appearance of their banks when steep and broken, so as to lay bare the different strata of earth adjoining to them. Pits, quarries, and wells, that have been dug in the neighbourhood, may also be examined with the same view. Rushes, small elder bushes, and other plants which grow on the wettest soils, also frequently afford symptoms of the line under which an internal reservoir of water is placed, and is pressing upwards from wanting a free passage below ground.

To drain the side of a hill.

It is often of much importance, even in sheep countries, to drain the side of a hill, not only because wet land is more unproductive than that which is properly drained, but because the superabundance of moisture is apt to introduce and to keep up among the flock that destructive and incurable disease, the *rot*, for which draining is an almost infallible preventive. It is cheaply executed in such situations, because the drains for collecting and leading off the water, may usually be left uncovered. Let it be supposed then, that in consequence of internal springs at a certain distance down the declivity of a hill, or upon any other descending surface, the ground becomes wet and spouty, and unwholesome for sheep, and unfit for agriculture; the best mode of proceeding with a view to drain it is this. It ought to be recollect ed, that the cause of the wetness is this: The rain water at the summit of the high ground is received into a porous stratum of gravel, with which it descends down the side of the hill, till it comes to be covered with a clayey soil. After descending under the covering of clay to some distance, the gravel or porous under soil suddenly ceases; the clay becomes deeper, and touches

touches the rock or another inferior bed of clay. In Preparation of Land. this situation, the water, unable to descend farther, re-gorges and presses upwards upon the clayey soil which covers it, rendering it moist and swampy in every part, and oozing through all its weaker crannies. Thus it forms a belt of moist ground along the face of the hill, from which the water perhaps descends and damages every part. To drain this declivity, begin at the bottom and carry up a ditch towards the wet ground. As the object is to let out the water at the lowest point of the reservoir or natural bag in which it is contained, by making an opening into the gravel there, it will be proper, as the ditch proceeds upwards, frequently to bore holes with an auger of about two inches diameter to a considerable depth, that is, about 15 feet, though sometimes it is necessary to go to twice that depth. As long as the water is not found by boring, the ditch must be carried upwards, and new auger holes formed; when at last the auger by boring reaches the lowest part of the gravel or reservoir of water, the water will immediately rush forth with considerable violence at the hole formed by it, and will continue ever after to run without any danger of choking up. When the bottom of the reservoir of water or layer of gravel is thus found, another ditch ought to be drawn across the head of the former along the face of the hill, so as to form the figure of the letter T. In the upper ditch or drain that runs along the face of the hill, auger holes ought to be bored at short distances, to let out the whole water from the interior reservoir or stratum of gravel. The whole process will be easily understood from considering Plate XV. Care ought always to be taken in digging the upper drain along the face of the hill,

Preparation to form it in such a way as that the water may descend
o' Land. in it towards the ditch first formed, which is intended
to convey it down the hill to the nearest brook. The
old practice or mode of draining ground in this situa-
tion before the use of the auger was understood, and
before men had reflected upon the way in which water
is often confined in the earth, consisting of digging a
trench wherever the spouty land commenced. As
this was not deep enough to reach the evil, that is, to
penetrate to the reservoir of water, it produced only a
partial remedy. Other parallel ditches of the same kind
were therefore cut the whole way down the declivity,
and being filled with loose stones and connected with a
descending ditch, each carried off only a portion of sur-
face water, leaving the soil still cold in consequence of
the wetness of the bottom.

In performing the operation already described, some
difficulties are apt to occur in consequence of the ir-
regularities with which the strata are often placed in the
earth. In boring in the ascending trench, in the first
part of the operation, with a view to discover the lowest
point at which the water may be let out from the inter-
nal reservoir, the operator is sometimes apt to be misled
by finding water before he has come high enough to
reach the place at which the porous stratum stops. This
arises from its sometimes happening that at the bottom
of the reservoir small leakages occur, and a portion of
the water finds its way downwards through crannies
in the earth to some distance from the main reservoir.
When the auger in boring meets these leakages, they
are apt to be mistaken for the main body of water,
and the operator can only guard himself against such
errors, by forming an estimate of the quantity of wa-

ter which the adjoining high grounds, ought to afford. Preparation
of Land.
If the quantity of water that follows the auger be very trifling, while the extent of high ground is great, he may be assured that he has not yet reached the great cause of the wetness of the soil. It also sometimes happens that the cross drain carried along the face of the hill, may in some places be below the level of the reservoir of water, while it is upon it at other places. In this case, when the auger by boring in the cross trench brings no water, it will be necessary to bore above it, and to conduct the water that is there obtained by a small cut into the general cross trench.

It sometimes happens that hills are composed of alternate strata, of rock and sand and clay, which rest horizontally or nearly so upon each other, and penetrate and form the mass of the hill. In such cases the soil above the sand or rock is often dry and productive, while the clay is wet and swampy. In this case, the highest part of the hill being generally porous, receives the rain water, which descends through it till it meets the impervious clay, which forces it to flow to the surface, which it renders wet. Having overflowed the upper clay surface, it is immediately absorbed by the next porous stratum; and descending into it in like manner, again issues at the lower side of it, and injures the surface of the next bed of clay, as it did that of the first. To drain a hill side of this description, it is necessary to make a trench along the upper side of every belt of rushy or boggy soil to receive the water from the superior porous soil, and to lead the whole water thus obtained by one or more ditches downwards to the bottom.

Where a soil is composed of intermixed varieties, with

Preparation clay predominating, it is sometimes very difficult to drain, as it is apt to form itself into a variety of hollow reservoirs, each of which holds water like a cup, while, at the same time, these hollows being full of porous materials, the surface of the soil is sufficiently regular. Thus, in wet seasons, patches of moist unwholesome soil are formed, not by springs for which they may be mistaken, but by rain water held up by clay in these disjoined cavities. They can only be drained by separate covered cuts, communicating in the shortest way possible with one or more main drains.

To drain a bog by letting the water ascend steadily.

With regard to the drainage of bogs, it has already been remarked, that they are either such as can have their water carried off by a communication, at a tolerable expence, with some adjoining lower ground; or they are land-locked, so as not to admit of being drained in this way. With regard to the former, or those which can be drained by trenches for conducting the water to an adjoining low country or river, they may be rendered wet in two ways: 1st, By springs oozing out of the adjoining higher ground, in a regular line along the upper side of the wet surface, which afford water that stagnates upon the surface of the inferior ground, forming it into a bog. To render free from water a bog of this kind, nothing more is necessary than merely to drain the upper adjoining swampy ground in the way that has been already stated, and to convey away to a distance the water produced by it, in regular, open, or hollow drains.—The second class of bogs rendered wet by springs, consists of those in which the many springs that appear are not confined to one regular direction along the upper side, but burst out everywhere, forming shaking quagmires, over which it is dangerous

dangerous for cattle to pass. The upper part of such ^{Preparation of Land.} bogs usually consists of peat-earth. Below that is found a bed of clay, extremely wet and soft, through the crannies of which small quantities of water are continually oozing. When the lowest part of such a bog is found, or the place in which it will be most convenient to convey away the water, little more is usually necessary than to dig proper trenches, and to bore with the auger through the stratum of clay to the porous stratum containing the water. To drain an extensive bog, it will usually be necessary to dig a trench from end to end of it, with cross trenches at considerable distances, the bottom of the whole being frequently penetrated with the auger, so as to allow a free passage for the water to ascend ; the effect of which will be, that the nature of the surrounding soft soil will speedily be altered, in consequence of the water being removed from beneath it. It will become dry and solid, and soon fit for bearing the plough. The same effect would follow although only a single perforation were made through the inferior stratum of the bog ; and accordingly Mr Elkington is said sometimes to have succeeded, while he drained a bog, in raising the water from it considerably above its own level, for any purpose for which it may be required. This was done by rearing around the perforation, a building of brick, puddled around and within with clay, to the top of which the water rose, and was from thence conveyed away in pipes or otherwise.

That the whole of this important subject, of draining land rendered wet by springs, may be better understood, we shall give an account of it as described by Dr Anderson, in his Essays published in 1775, already mentioned.

Preparation mentioned. Supposing, says he, a descending stratum
of Land. of sand or gravel should be discontinued, and that the
stratum above it should be of a coherent clayey nature —
in this case, the water being pent in on every side, and —
being accumulated in great quantities, must at length —
force a passage for itself in some way, and pressing —
strongly upon the upper surface, if any one part is —
weaker than the rest, it would burst forth, and form —
spring; but if the texture of every part of this stratum —
were equally strong, the water would squeeze through —
many small crannies, and would ooze out in number —
less places, so as to occasion that kind of wetness that —
is known by the name of a spouting clayey soil.

The cure in this case is easily effected.—For if —
ditch of a considerable size is opened towards the lower —
moist part of the spouting ground, so deep as to pene —
trate through the upper stratum of clay, and reach —
the gravel, the water will rise up through it at fir —
with very great violence, which will gradually decreas —
as the pressure from the water behind is diminished ;
and when the whole of the water accumulated in the —
subterraneous reservoir is run off, there being no long —
er any pressure upon the clay above it, the whole soon —
becomes as dry as could be desired, and continues —
ever afterwards, if the ditch is always kept open. This —
is the doctor says he can assert from experience, hav —
rendered some fields of this kind that were very wet —
quite dry by this method of treating them. The —
tentive observer, he adds, will readily perceive, that —
if any field that is wet from this cause admits of being —
ploughed, it will be in equal danger of being hurt by —
being raised into higher ridges, with the other kind of —
damp ground before mentioned. For as the depth of —
earth

earth above the reservoir would be smaller in the deep furrows than anywhere else, there would of consequence be less resistance to the water in that place, so that it would arise there in greater abundance. And if, in this case, a farmer should dig a drain in each furrow, as a considerable quantity of water would rise into them, in some cases the ground might be improved, or even quite drained thereby, especially if they should have accidentally reached the gravel in any one place; although at an expence much greater than was necessary.
“ I take notice of this circumstance, says he, in some measure to prevent the prejudice that some inattentive observers might entertain against what was said before of this method of draining, from their having accidentally seen some fields that may have been bettered by it.

“ Bogs are only a variety of this last-mentioned kind of wet ground; and, therefore, ought in general to be drained after the same manner with them. Clay is a substance that strongly resists the entrance of water into it: but when it is long drenched with it, it is, in process of time, in some measure dissolved thereby; loses its original firmness of texture and consistence; and becomes a sort of semi-fluid mass, which is called a *bog*, and as these are sometimes covered with a strong scurf of a particular kind of grass, with very matted roots, which is strong enough to bear a small weight without breaking, although it yields very much, it is in these circumstances called a *swaggle*. But, whatever be the nature of the bog, it is invariably occasioned by water being forced up through a bed of clay, as just now described, and dissolving or softening, if you will, a part thereof. I say only a part; because whatever may be

the

Preparation the depth of the bog or swoggle, it generally has a partition of solid clay between it and the reservoir of water under it, from whence it originally proceeds: for if this were not the case, and the quantity of water were considerable, it would meet with no sufficient resistance from the bog, and would issue through it with violence, and carry the whole semi-fluid mass along with it. But this would more inevitably be the case, if there was a crust at the bottom of the bog, and if the crust should ever be broken, especially if the quantity of water under it were very considerable: and as it is probable that, in many cases of this sort, the water slowly dissolves more and more of this under crust, I make no doubt but that, in the revolution of many ages, a great many eruptions of this kind may have happened, although they may not have been deemed of importance enough to have the history of them transmitted to posterity. Of this kind, although formed of a different substance, I consider the flow of the Solway moss in Northumberland to have been; which, upon the 16th of November 1771, burst its former boundaries, and poured forth a prodigious stream of semi-fluid matter which in a short time covered several hundred acres of very fine arable ground. Nor will any one, who is acquainted with the nature of moss,—who knows its resemblance to clay in its quality of absorbing and retaining water, and its very easy diffusibility therein, be surprised at this; as from all these properties, it is much better adapted for forming an extensive bog, and therefore in greater danger of producing an extensive deviation by an irruption of the water into it, than those that are formed of any kind of clay whatever.

" If the bog, or swampy ground, is upon a declivity,

the ditch ought to be carried across the field about the place where the lowest springs arise. But if the surface of the ground is level or nearly so, so as to form soft quagmires, interspersed through the whole of the field, it will be of little consequence in what part the drain is opened; for if it is dug up so deep as to allow the water to rise in it with freedom, it will issue through that opening, and the field will be left perfectly dry.

" But as it may frequently happen that the stratum of gravel should be at a considerable depth beneath the surface of the earth, and as it may be sometimes even below the level of the place into which the drain must be emptied, it might sometimes be extremely difficult to make a ditch so deep as to reach the bed of sand or gravel. But it is lucky for us that this is not absolutely necessary in the present case; as a drain of two or three feet deep, will be equally effectual with one that should go to the gravel. All that is necessary, in this case, is to sink pits in the course of the drain, at a moderate distance from one another, which go so deep as to reach the gravel; for as the water there meets with no resistance, it readily flows out at these openings, and is carried off by the drain without being forced up through the earth; so that the ground is left entirely dry ever after.

" I have likewise drained several fields in this way: and as I have generally found the appearances pretty much alike, I shall, for the information of the inexperienced reader, give a short account of them.

" If you attempt to make your pit in one of these soft quaggy places where the water is found in great abundance, you will meet with very great difficulty in forming

PRACTICE OF

forming it; for as the substance of which it is composed is soft, it will always flow into the hole as fast as you dig it; on which account I would advise, not to attempt to make the pit in the swaggle, but as near it in the solid earth as you conveniently can. However, if it is pretty firm, and of no great extent, it is sometimes practicable to make a pit in the soft bog at the driest time of the year. This I have sometimes practised, which gave me an opportunity of observing the nature of these bogs more perfectly than I otherwise would have had. In the trials of this kind that I have made, this soft quaggy ground has seldom been above three or four feet deep; below which I have always found a stratum of hard tough clay usually mixed with stones, and so firm that nothing but a mattock or pick-axe could penetrate it: and as this is comparatively so much drier than the ground above it, an inexperienced operator is very apt to imagine that this is the bottom that he is in search of. In digging through this stratum you will frequently meet with small springs oozing out in all directions; some of them that might fill the tube of a small quill, and others so small as to be scarce perceptible: but without regarding these, you must continue to dig on without intermission till you come to the main body of the reservoir, if I may so call it, that is contained in the rock, gravel, or sand; which you will generally find from two to four feet below the bottom of the swaggle, and which you will be in no danger of mistaking when you come to it: for, if there has been no opening made before that in the field, as soon as you break the crust immediately above the gravel or rock, the water bursts forth like a torrent, and on some occasions rises like a *jet d'eau*, to a considerable height above

the bottom of the ditch ; and continues to flow off with great impetuosity for some time, till the pent-up water being drained off, the violent boiling up begins to subside, and the strength of the current to abate ; and, in a short time, it flows gently out like any ordinary spring ; —allowing it to remain in this state, the quaggy earth begins to subside, and gradually becomes firmer and firmer every day ; so that, in the space of a few months, those bogs which were formerly so soft as hardly to support the weight of a small dog, become so firm that oxen and horses may tread upon them without any danger of sinking, at the very wettest season of the year. I have had a field of this nature, that, by having only one such pit as I have now described opened in it, was entirely drained to the distance of above a hundred yards around it in every direction. But as it is possible that the stratum in which the water runs may be in some places interrupted, it will be in general expedient to make several of these pits, if the field is of great extent; always carrying the drain forward through the lower-most part of the field, or as near the quag as you conveniently can ; and sinking a pit wherever you may judge it will be most necessary. But if the stratum of gravel is not interrupted, there will be no violent burst of water at opening any of these after the first, as I have frequently experienced. To keep these wells from closing up after they are made, it is always expedient to fill them up with small stones immediately after they are made, which ought to rise to the height of the bottom of the drain.

“ I have often imagined that the expence of digging these pits might be saved by boring a hole through this solid stratum of clay with a large wimble made

on

Preparation on purpose; but as I never experienced this, I can't say whether or not it would answer the desired end exactly.

" If the whole field that is to be drained consists of one extensive bog, it will require a long time before the whole work can be entirely finished, as it will be impossible to open a drain through it till one part of it is first drained and become solid ground. In a situation of this kind, the undertaker, after having opened a drain to convey the water from the lowest part of the bog, must approach as near to the swampy ground as he can, and there make his first pit; which will drain off the water from the nearest parts of the bog. When this has continued open for some time, and that part of the bog is become so solid as to admit of being worked, let him continue the ditch as far forward through it as the situation it is in will admit of, and there sink another pit; and proceed gradually forward in the same manner; making cross cuts where necessary, till the whole be finished.

" In this manner may any bog or tract of spouting ground of this nature be rendered dry at a very inconsiderable expence; and as there can be no other method of draining ground of this sort effectually, I recommend the study of it to the attention of every diligent farmer who may have occasion for it. Let him first be extremely cautious in examining all the circumstances of his particular fields, that he may be certain which of the classes above enumerated it may be ranked with; and when he is perfectly sure of that, he may proceed without fear, being morally certain of success.

We shall add the substance of a paper on this subject,

ject, for which the author received the silver medal of Preparation of Land, the Society instituted for the encouragement of Arts, Manufactures, and Commerce. That author is Mr John Wedge of Bickenhill, near Coventry, who is ^{Mr Wedge's mode of} draining, not only a great farmer himself, but had likewise been employed by the earl of Aylesford in the management of several estates. Encouraged by his lordship's liberality, Mr Wedge informs the society, that he had been employed for some years in draining large portions of land, of which part was in the earl's occupation, and part in his own, as tenant to his lordship. The principles upon which he proceeded, as well as his mode of procedure, he states in the following terms :

In every country there are large portions of land that, in wet seasons, have always what may be called a *dry surface*, and other portions of land that have always a *moist* or *wet surface*; the former of these admitting all the water which falls upon them to sink freely through their pores to various depths, till falling on clay, or some other unctuous earth, whose pores will not permit it to pass through, it is there held up to a height proportioned to the quantity of water which comes upon it, and the facility with which that water is discharged. Thus, held up to various heights, it serves as a fountain to distribute its water (either by veins of sand, pebbles, or rock, according to the formation of the different under strata) on the neighbouring lands; and there forms bogs and other varieties of wet surface, on a basis that will be always found to consist of marl or clay, or some mixture thereof. The effect of water thus distributed may be divided into two classes. The first class, where the water is thrown out by a body of marl or clay, &c. upon the surface of descend-

Preparation^{ing} ground, and in the valley (there held up by clay of Land. also) forms bogs or swamps. The second class, where the water is held up by marl or clay, as before, having above that marl or clay a stratum of sand, or pebbles, through which the water passes; and above those sands or pebbles another stratum of marl or clay, through the weakest parts of which the water, by a continual pressure from its fountain, forces a passage upwards; and thus, through the weakest parts of the marl or clay, furnishes a continual supply of water on the surface, for the formation or growth of bogs, &c. in proportion as this water is more or less abundantly supplied by its fountain or head, namely, the higher lands, into which rain-water freely passes, as before described. There are also different soils, under different circumstances, which may form a third class of land for draining; such as strong deep soils, or open light soils, having near the surface a body of marl or clay. In either of these cases, the water which falls on the surface must for reasons which are self-evident, keep such lands, in rainy seasons, constantly wet and cold; and it should be observed, that a mixture of all the three before-described classes of wet land sometimes occurs in one field, by sudden alterations of the under strata, and thereby perplexes the operator, by requiring all the different modes of draining in the same field.

If it be admitted that bogs are thus formed and fed, their cure may be effected with certainty: The first class, by cutting through the stratum (be it sand, pebbles, or rock), that conveys the water to the bog, and carrying off that water by a close drain to some proper place, where the level admits of its discharge: The second class, by sinking a drain to any convenient depth in

in the upper clay; and then digging or boring with Preparation of Land.
a large auger, at a small distance on one side of this drain, through the remaining part, be it (the upper clay) ever so deep, into the under stratum of sand, pebbles, or rock, through which the water passes; which will then rush up into the drain so made, with a velocity proportioned to the height of the land or fountain whence it is supplied. As this drain advances through the land, holes must be dug or bored, as before, every seven yards, or at such distance as the strength of the springs may require; and the whole of the water thus brought up by tapping the springs, is carried off by the drain made in the upper clay, which must be a close one, to its proper level, and there discharged.

By both these methods of draining, large tracts of land, under favourable circumstances, may be cured with one drain. The best place for fixing these drains is where the stratum that conveys the water comes nearest to the surface; and the best method of ascertaining that, is to bore or dig in different parts through the different under strata.

The third class may be easily cured by close drains, at such distances and depths as will best carry off the surface-water. It may not be improper to observe, that where the different strata or measures crop out, that is, become gradually more and more shallow in some certain direction (as is often the case, till, one after the other, they all present themselves in succession on the surface of the earth), draining may often be much more easily and better effected by crossing with the drain the different strata or measures, where the levels and other circumstances will admit.

Some of the land drained was part of a common, in
Z 2 the

Preparation of Land the parish of Church Bickenhill, in the county of Warwick ; part of it was covered with moss and ling, had a peaty surface, about six inches deep, and produced little or no grass : in all wet seasons it was filled quite to the surface, and often overflowed, with water. Some of the land was much more unsound, deeper of peat, and covered with moss, in most parts nine inches long ; another part was an absolute bog in all seasons.

Having dug or bored with a large auger into several parts of the land, Mr Wedge found peat, gravel, and sand mixed, and a quicksand almost uniformly. The quicksand in every part, after getting an inch or two into it, seemed almost as fluid as water. Judging from this, that no materials for a drain could be laid in the quicksand, but what it would immediately bury, he dug a trench almost to the quicksand, leaving gravel, &c. of sufficient strength to bear up the materials for a hollow drain ; these materials were two sides and a coverer of stone, with a peat-turf on the top to keep out the soil. At every seven yards forward, by the side of this drain, he dug a hole in the quicksand as deep as it would permit. From these holes the water rose freely into the hollow drain, and was by it discharged at a proper level. It may be proper to remark, that the stone made use of for this drain, and all others here mentioned, was a red sand and rag-stone, which easily split into proper sizes for the purpose, and is very durable ; it cost about sixpence per ton getting, exclusive of carriage. The drain thus formed ran on the whole rather freely, and made the land dry for a few yards on each side thereof, but was far from having the effect he improperly expected ; for it evidently appears that the drain could only take a very small portion of the water from

from so large a quicksand, which it did not penetrate Preparation
more than two inches ; and that it could drain only to of Land.
its own depth, or, at most, to that depth in the fountain
which supplied the quicksand. His purpose was then
defeated ; and his motive for mentioning this error can-
not, he hopes, be mistaken.

He now did what he says he ought to have done before, that is, he examined the different strata to a greater depth, particularly on the bog, and at the upper edges thereof, and found the bog to be what has been described under the first class. He therefore determined to attempt the cure in the manner before prescribed for that class, namely, to cut through the whole of the stratum (in this instance, of quicksand), through which he found the water pass. This he effected as follows : The summer being dry, and favourable for the purpose, and having previously made his main open drain, he began his main close drain the first week in June 1791, three feet wide, on the declivity near the edge of the great bog. In the first operation he dug through the peat, the hard sand, and gravel, and one spade's graft (about nine inches deep, and seven inches wide) into the quicksand the whole length of this drain, which was 73 perches, of eight yards to the perch, in length. The drain thus dug ran copiously, not less than 60 gallons per minute. In this state he left it about nine days : the effect of it was rapid, both above the drain and on the bog below. Upon examination, he now found about three inches on the top of the spade's graft, which had been made into the quicksand, perfectly dry. He then dug out these three inches of dry sand, to nearly the whole width of the drain, three feet ; and at the same time dug out, as before, another spade's graft,

Preparation from the top of the quicksand, as near the middle of the Land. the drain as possible. This was left to run a few days, as before, and had the same effect ; namely, three or four inches more of the top of the quicksand became dry and hard. The same operation was repeated again and again with the same effect, till the purpose of getting through this quicksand was completed, so far at least as the level of the main open drain would permit. The stream of water continued increasing during the whole operation ; the bog below the drain was quite dry, and the land above perfectly so. The drain which was first made, and continued running for some time during the progress of the main close drain, became gradually dry ; and has not, since that drain was finished, discharged one single drop of water. Great care was necessary, in making the main close drain, to keep the stream of water in the middle of it, otherwise the current would have undermined the sides, as it sometimes had done, and caused them to fall in. For this reason it was necessary, when the dry sand was taken from the top of the quicksand, immediately to take out a spade's graft from the middle thereof, in order to divert the current from the sides.

The main close drain thus made was three feet wide at top, about nine feet deep on the average, and, beveling a little from the top, it was about one foot ten inches wide at the bottom. The stone and other materials were put into this drain in the following manner : 1. Where the drain went through the quicksand into the stratum of clay below it, as in most places it did, the bottom, and in some instances the sides, wanted no particular security ; but where it did not go quite through the quicksand, which the level of his main open

open drain in some places would not admit, the bottom Preparation
of Land.
of the drain was covered half an inch thick with ling ; —
then peat turfs, one foot wide and three or four inches
thick, were cut in convenient lengths, and placed on
their edges on each side of the bottom of the drain,
forming two sides of a trough of peat ; then side stones
about eight inches high, and a stone coverer, were put
in upon the ling between the peat turfs ; a large peat
turf, near two feet wide and four inches thick, was
then cut and firmly placed over the whole : this left in
the bottom of the drain an open space, of more than
six inches square, for the water to pass. The whole
was then completed by filling in the upper part of the
drain.

In this way Mr Wedge drained for about 80L thirty
acres of land, which from being of no value whatever,
became worth at least 14 shillings per acre of yearly
rent. He likewise hollow-drained nine acres by the
method prescribed for the third class of wet land. These
drains were made a few yards below that part of each
field where the dry and wet land separate, about 22
inches deep, with sides and a coverer of stone, and ling
on the top of it, to keep the earth from running in.
The length of these drains was 880 yards, and the ex-
pence of labour and materials three halfpence per yard.
The drains, in wet weather, discharge a large quantity
of water ; and will, he has no doubt, answer the in-
tended purpose. Thus far relates to land in his own
occupation.

Nine acres of the land in the earl of Aylesford's oc-
cupation was almost an entire pulp. This bog was of
the second class, namely, water passing through a quick-
sand, and confined by a stratum of clay below, and

Preparation at
of Land. stratum of clay above it. The water thus confined, being pressed by its fountain, and forced up through the weakest parts of the clay, had formed a bog of irregular thickness on the surface, in some places six feet deep, in others not more than two. As there is a considerable fall in this land from east to west, he thought it expedient to put two drains into it; and this appears to him to have been necessary, from a consideration that both these drains continue to run in the same proportions as when first opened. The manner in which these drains were executed was, by digging through the different upper strata, and as deep into the clay as the main open drain would admit; then digging or boring through the remaining part of that clay into the quicksand, at the distance of about six yards, in a progressive manner.

The water rising rapidly through these holes into the close drains, has effected a complete cure of this land, every part of which will now bear a horse to gallop upon it. These drains discharge 3660 gallons an hour; which is much less than they did at first, as must be the case in all bogs. This land will be worth 20s. per acre. The draining cost 25l.; and the length of the under-ground drains is eight hundred and fourteen yards.

Mr Wedge had just finished (January 1792) draining another piece of land, about forty-three acres. As this was intended to answer two purposes, one, to drain the land, the other to give an additional supply of water to a mill-pool, and as a circumstance arose in the execution of the work which frequently happens in draining land, namely, a sudden alteration in the position of the under strata; a description thereof will not probably

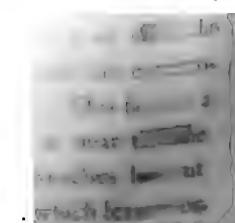
probably be thought tedious. This draining was begun Preparation
at the level of a mill-pool, and continued, without any of Land.
great difficulty, to the distance of about thirty-two
chains, in the manner before described as a cure for
the second class of boggy land : but at or near that place
the under strata altered their position ; the quicksand
which conveyed the water now became of twice its for-
mer thickness ; and the clay, which had hitherto been
above that quicksand, for some distance disappeared.
From the quicksand thus becoming so much deeper,
he could not, with the level of the mill-pool, cut
through it ; nor indeed, from the wetness of the season,
would such an operation have been proper. He there-
fore continued a shallow drain to some distance, making
side-holes into the quicksand, which ran freely ; but as
this could not cure the whole of the bog below, he
branched out another drain (which was made by the
method described for curing the second class of wet or
boggy land), by sinking a close drain through the upper
strata into the upper clay, and then, at a small distance
on one side of this close drain, boring a hole with an
auger through the remaining part of that clay into the
quicksand ; and at every eight yards, as this close drain
advanced, still boring other holes, in the manner before
described : through many of these holes the water rush-
ed with great rapidity. The water discharged by these
drains into the mill-pool is 168 gallons per minute, or
3780 hogsheads in a day ; which is after the rate of
1,379,700 hogsheads in a year.

About six acres of this land were always found ; a-
bout twelve acres on the north side were an absolute
pulp, and the remaining twenty-six acres very unsound.
The whole is now sound, and will when cultivated be
worth

~~Preparation worth 16s. per acre.~~ This land would have been d
of Land. ~~ed at a much less expence into the main open c~~
~~but then the water, which was much wanted f~~
~~mill, would have been lost. These close drain-~~
~~length 1452 yards, and cost 100l. of which ab-~~
~~ought to be charged to the mill.~~

**§ 3. Of Draining Land-locked Bogs or Lands,
declivity cannot be obtained to carry off the**

~~Draining of~~ With regard to the drainage of land-locked bogs, which are often situated so much lower than around them, that the cutting a main drain more than the value of the land when mode of proceeding, with a view at and effectually to relieve them from the moisture which renders them useless to the following : A spot in the middle of the bog must be selected, towards which must be conducted, as radii to a When this central spot is properly top of the clay, or retentive substratum, case must not be affected by water only by surface or rain water, a number must be made with the auger, to give passage for the water, which will porous stratum below. A covering over the auger holes, by loose stones in manner as to prevent their being filled by any rubbish : or rather auger a pit, or well, in the lowest part into the porous substrata. The bottom with large stones, and the dr



field conducted to that spot, as mentioned in the following quotation from the Agricultural Report of Hertfordshire.—“ If a pit is sunk 20 or 30 feet deep in the middle of a field, through the Hertfordshire red, flinty, and impervious clay, into the chalk below ; when the usual quantity of chalk is taken out, the pit shaft is filled up with the flint taken out of the chalk and clay, and the top drainage of this part of the field is much shortened for ever afterwards, by making principal drains from the part of the field above the level of the top of the pit terminate therein, as the superabundant moisture will escape through the flints in the pit shaft to the chalk below. And if a drain is carried into a limestone quarry, it is seldom necessary to carry it further.

“ In dells or hollows, of considerable extent, covered with an impervious stratum, and from which there is no natural drainage, such as the valley between Mold, the shire-town of Flintshire, and the adjoining high land, a pit about four feet diameter, and 15 feet deep, more or less, as the case may require, is sunk through the impervious superstratum, into a pervious stratum of gravel, and the rain water, and that of some adjoining springs, are carried from the surface thereby ; the pit is railed round to prevent cattle from falling into it. I must here remark, that though in this, as well as in many other instances that may be given, the top water escaped through the pervious substratum, the effect might have been directly the contrary. I therefore recommend the impervious superstratum, in all such cases, to be perforated by bore-rods, as the hole made by them is easily stopped up.”

In Dr Nugent's travels through Germany, published
in

~~Preparation of Land.~~ a pair of boring rods were obtained, which were put down through the flaty substance to the whinstone rock at sundry places. This effectually answered the purpose. The tops of the holes were kept open with baskets of loose stones over them, which were allowed to remain or removed at pleasure, as the weather proved more or less wet. In spring 1786 the land was in condition to be sown almost as early as any other part of the farm, the winter rains having found their way down into the whinstone rock through the flaty substance. The land speedily became and continued very valuable.

~~Draining of quarries and stated mines.~~ We may here add, that the modes of draining now stated are also valuable for other purposes than those of agriculture. Quarries, for example, and marl pits may often be cleared of water, by cutting off the springs by which they are incommoded, or by letting down the water into the next porous stratum. The same may be often done, with regard to deep mines, the working of which may frequently be thus greatly facilitated. A colliery, for example, in Yorkshire had been wrought for several years, and the water was raised from it about 60 yards by a steam engine. The proprietors having bored about ten yards farther, to ascertain the thickness of a seam of coals; as soon as the boring rods were withdrawn, the water from the works, which usually ran across that place, began to sink into the holes made by the rods; and, continuing to do so, the steam engine became useless, as its pump had no longer any water to draw. It must be observed, that the situation was higher than the nearest valleys, or the level of the sea; but this example shows of what extensive importance a knowledge of the principles upon which

the above modes of draining proceed may hereafter Preparation
of Land.

3. Of rendering Mosses fit for Cultivation.

In many parts of the country a very serious obstruction to the cultivation of large portions of territory arises from the existence of mosses. It is, therefore, of much importance to consider their nature, and how they are to be rendered fertile.

With regard to the nature and origin of moss, the Nature and origin of celebrated Dr Anderson, whose works we have already mosses. frequently quoted, advances this opinion, that moss is a vegetable, or an assemblage of vegetables, growing or living below, while at the top it is dead. Hence, he distinguishes moss into two kinds; quick moss, from which peats are dug, on which no vegetables grow, and in which no animals exist, while in its natural situation; and dead moss, which frequently covers the former, and upon which heath and fog and coarse grasses grow, and insects and other animals are found. Mr Head-tick* states various objections to this opinion, some of which appear to have great force. Thus, it is observed, that the moss here supposed to be alive below the soil, has every mark of utter deadness and partial dissolution. When tossed about in a very dark night, it emits light like half-rotten wood, giving rise to frequent terrors in those who live in the vicinity of peat bogs. It also seems a strange circumstance, and contrary to the whole analogy of nature, to suppose that a vegetable should grow, should form ligneous fibres, and acquire

* *Communications of the Board of Agriculture*, vol. ii.

~~moist~~ acquire inflammability, without the influence of the ~~of land~~ sun, or coincide with the ~~as~~, during any period of its growth. The true history of the origin of moies seems to be this: What are called the moss plants, amount to about three hundred in number. They are extremely hardy, and are capable of flourishing in the most cold and bleak situations, providing only they are surrounded by abundance of stagnating water. Accordingly, whenever water stagnates in a moderate quantity, they grow up, and, by spreading themselves around, they increase the stagnation. When they have arisen in this manner, with the water around them, to a considerable height, the lower part of their stems being continually soaked or macerated in water, cease to vegetate, and give forth their juices to the surrounding fluid. As the moss plants are extremely astringent, and contain large quantities of the gallic acid and tanning principle, the moss water acquires these qualities, or becomes astringent, in a great degree, and prevents any process of putrefaction from taking place, or the stems of the moss plants from undergoing any proper process of rottenness, or chemical decomposition. Hence it is, that moss water has sometimes been used for tanning leather, in the same manner as is the liquor of oak bark. In the mean time, while the stems of the moss plants remain in this manner dead, but prevented from rotting, or becoming the habitat of animals which cannot live in a vegetable astringent liquor, the tops of the plants that are at the surface of the water continue to grow, or new plants rise upon the summits of the dead ones, and continue their ascending progress; the whole being perhaps a sort of parasitic plant, which can grow upon each other.

In this way, a moie proceeds, rising higher and higher, till

till from the nature of the adjoining country, and the Preparation
declivities in it, the water cannot stagnate to any greater
of Land. depth. After the moss has come to this height, its
farther growth is prevented : its plants, unable to live
or grow without abundance of water, wither and die ;
the upper part of them being exposed to the action of
the air, suffers an ordinary process of decomposition,
like other vegetable remains, and is converted into a
sort of soil, upon which a few plants and reptiles are
sometimes found ; while at a small depth, that is to
say, below the surface of the stagnating water, the
whole stems of the ancient moss plants continue macer-
ated in their own liquor, and preserved from putre-
faction by it.

There are, however, two general kinds of mosses ; black and
black moss, and whitish or yellow moss. The black ^{yellow} moss
moss is originally of a mahogany colour, but speedily
becomes black upon exposure to the air. The yellow-
ish, or foggy moss, is much less compact than the for-
mer, and retains a light or yellowish colour after it is
dried. It does not appear to be in such a perfect state
of maceration as the black moss, has less variety of
plants, and is never so solid. It is usually produced in
low warm situations, and appears to have grown ra-
pidly ; whereas, the black moss is most commonly found
in cold elevated lands, and seems to have consisted of
a greater number of less luxuriant plants. Thus, moss
may be regarded as bearing some resemblance to timber,
which is always of a compact grain, and close texture,
in proportion to the severity of the climate of which it
is the product, or rather in proportion to the length of
time which it has taken to grow.

From what has been here stated, it will not be diffi-

Preparation cult to understand the mode in which mosses come ori-
of Land. ginally to find an existence, or to cover a piece of ter-
ritory in any country. When a pool of water is speed-
ily, or in a short time, formed to a great depth, no
moss appears ; but when a gradual stagnation to a small
depth takes place, upon any spot, especially in a cold
and exposed situation, there the moss plants (being the
only ones capable of subsisting on such a soil) speedily
grow up, and occupy the place of every other. Though
the quantity of water that originally stagnated there
might not be great, it is increased by degrees, in con-
sequence of the additional obstruction produced by the
roots, stems, and leaves of the moss plants, till at last
it forms a bog of very great depth.—We have already
mentioned the nature and causes of the stagnation of
water. It may either occur in consequence of the
figure and quality of the soil making it tenaciously to re-
tain the falling rains, or it may be the consequence of
springs or reservoirs of water pent up or confined in the
bowels of the earth by an incumbent mass of clay.
Struggling to rise up through this clay, it will wet
every part of it, and will slowly ooze through all its less
adhesive parts, and will form a soil fit only for the re-
ception of moss plants, which will there, by obstructing
the departure of the moisture, which is constantly rising,
in the course of years rear up the surface into a complete
and perfect peat-bog.

But mosses not only arise in particular situations, in
consequence of these operations of nature ; they are
also produced as the result of certain exertions of human
industry. In almost all our mosses in this country great
numbers of trees of various sorts are found. They re-
main, like the inferior parts or roots of moss plants, in-
Mosses pro-
duced by
cutting
down
forests. fused

fused and macerated in the moss water, but not rotted. Preparation of Land.
The trees and shrubs found at the bottom of mosses in Scotland, exhibit, perhaps, the whole variety of the native trees and shrubs. Of trees, are found the oak, the elm, the birch, the willow, the alder, and the fir. Of shrubs, we find the hazel, the dwarf willow, the gall plant, and lastly, the heath plant. This last is of so hardy a nature, that it often continues to rise upon the moss during the whole period of its existence. Now, if it should be supposed, that at any time extensive forests of these trees were suddenly cut down by the exertions of man, they would undoubtedly produce a stagnation of water, and a bleakness of climate, that would render the situation fit only to be inhabited by moss plants, which would, therefore, speedily rise up, and form a peat-bog, in which multitudes of trees and shrubs would be found soaked in their own juice, and in the astringent liquor resulting from the maceration of the stems of the moss plants. That in ancient times old forests were thus destroyed by the efforts of man, we have every reason to believe. Not only in this country, but also in England and Ireland, there are found in mosses vast numbers of trees standing with their stumps erect, and their roots piercing the ground in a natural posture as when growing. Many of those trees are broken or cut off near the roots, and lie along, and this usually in a north-east direction. People who have been willing to account for this, have usually resolved it into the effect of the deluge in the days of Noah ; but this is a very wild conjecture, and is proved false by many unanswerable arguments. The waters of this deluge might indeed have washed together a great number of trees, and buried them under loads of earth ;

Preparations but then they would have lain irregularly and at ran-
of Land. dom : whereas, in this case, the trees all lie lengthwise from south-west to north-east, and the roots all stand in their natural perpendicular posture, as close as the roots of trees in a forest.

Besides, these trees are not all in their natural state, but many of them have the evident marks of human workmanship upon them, some being cut down with an axe ; some split, and the wedges still remaining in them ; some burnt in different parts, and some bored through with holes. These things are also proved to be of a later date than the deluge, by other matters found among them, such as utensils of ancient people, and coins of the Roman emperors.

It appears from the whole, that all the trees which we find in this fossil state, originally grew in the very places where we now find them, and have only been thrown down and buried there, not brought from elsewhere. It may appear indeed an objection to this opinion, that most of these fossil trees are of the fir kind ; and that Cæsar says expressly, that no firs grew in Britain in his time : but this is easily answered by observing that these trees, though of the fir kind, yet are not the species usually called the *fir*, but pitch tree ; and Cæsar has nowhere said that pitch trees did not grow in England. Norway and Sweden yet abound with these trees ; and there are at this time whole forests of them in many parts of Scotland, and a large number of them wild upon a hill at Wareton in Staffordshire to this day.

In Hatfield marsh, where such vast numbers of the fossil trees are now found, there has evidently once been a whole forest of them growing. The last of these

these was found alive, and growing in that place, Preparation
within 70 years last past, and cut down for some com- ^{of Land.}mon use.

It is also objected by some to the system of the firs growing where they are found fossil, that these countries are all bogs and moors, whereas these sorts of trees grow only in mountainous places. But this is founded on an error; for though in Norway and Sweden, and some other cold countries, the fir kinds all grow upon barren and dry rocky mountains, yet in warmer places they are found to thrive as well on wet plains. Such are found plentifully in Pomerania, Livonia, Courland, &c.; and in the west parts of New England there are vast numbers of fine stately trees of them in low grounds. The whole truth seems to be, that these trees love a sandy soil; and such as is found at the bottoms of all the mosses where these trees are found fossil. The roots of the fir kind are always found fixed in these; and those of oaks, where they are found fossil in this manner, are usually found fixed in clay; so that each kind of tree is always found rooted in the places where they stand in their proper soil; and there is no doubt to be made but that they originally grew there. When we have thus found that all the fossil trees we meet with once grew in the places where they are now buried, it is plain that in these places there were once noble forests, which have been destroyed at some time; and the question only remains how and by whom they were destroyed. This we have reason to believe, by the Roman coins found among them, was done by the people of that empire, and that at the time when they were established or establishing themselves here.

~~Preparation of Land.~~ Their own historian tells us, that when their armies pursued the wild Britons, these people always sheltered themselves in the miry woods and low watery forests. Cæsar expressly says this; and observes, that Cassibelan and his Britons, after their defeat, passed the Thames, and fled into such low marshes and woods that there was no pursuing them: and we find that the Silures secured themselves in the same manner when attacked by Ostorius and Agricola. The same thing is recorded of Venutius king of the Brigantes, who fled to secure himself into the boggy forests of the midland part of this kingdom: and Herodian expressly says, that in the time of the Romans pushing their conquests in these islands, it was the custom of the Britons to secure themselves in the thick forests which grew in their boggy and wet places, and when opportunity offered, to issue out thence and fall upon the Romans. The consequence of all this was the destroying all these forests; the Romans finding themselves so plagued with parties of the natives issuing out upon them at times from the forests, that they gave orders for the cutting down and destroying all the forests in Britain which grew on boggy and wet grounds. These orders were punctually executed; and to this it is owing that at this day we can hardly bring to believe that such forests ever grew with us as are now found buried.

The Roman histories all join in telling us, that when Suetonius Paulinus conquered Anglesea, he ordered all the woods to be cut down there, in the manner of the Roman generals in England: and Galen tells us, that the Romans, after their conquest, kept their soldiers in Britain constantly employed in cutting down forests, draining

draining of marshes, and paving of bogs. Not only the Preparation of Land.
Roman soldiers were employed in this manner, but all the native Britons made captives in the wars were obliged to assist in it: and Dion Cassius tells us, that the emperor Severus lost no less than 50,000 men in a few years time in cutting down the woods and draining the bogs of this island. It is not to be wondered at, that such numbers executed the immense destruction which we find in these buried forests. One of the greatest subterranean treasures of wood is that near Hatfield; and it is easy to prove, that these people, to whom this havock is thus attributed, were upon the spot where these trees now lie buried. The common road of the Romans out of the south into the north, was formerly from Lindum (Lincoln) to Segelochum (Little Burrow upon Trent), and from thence to Danum (Doncaster), where they kept a standing garrison of Crispinian horse. A little off on the east, and north-east of their road, between the two last named towns, lay the borders of the greatest forest, which swarmed with wild Britons, who were continually making their sallies out, and their retreats into it again, intercepting their provisions, taking and destroying their carriages, killing their allies and passengers, and disturbing their garrisons. This at length so exasperated the Romans, that they were determined to destroy it; and to do this safely and effectually, they marched against it with a great army, and encamped on a great moor not far from Finningly: this is evident from their fortifications yet remaining.

There is a small town in the neighbourhood called *Osterfield*; and as the termination *field* seems to have been given only in remembrance of battles fought near the towns whose names ended with it, it is not impro-

Preparation bable that a battle was fought here between all the
of Land.
Britons who inhabited this forest and the Roman troops
under Ostorius. The Romans slew many of the Britons, and drove the rest back into this forest, which at
that time overspread all this low country. On this the
conquerors, taking advantage of a strong south-west
wind, set fire to the pitch-trees, of which this forest
was principally composed ; and when the greater part
of the trees was thus destroyed, the Roman soldiers and
captive Britons cut down the remainder, except a few
large ones which they left standing as remembrances of
the destruction of the rest. These single trees, how-
ever, could not stand long against the winds, and
falling into the rivers which ran through the country,
interrupted their currents ; and the water then over-
spreading the level country, made one great morass, and
gave origin to the mosses or moory bogs, which were af-
terwards formed there, by the workings of the waters,
the precipitation of earthy matter from them, and the
putrefaction of rotten boughs and branches of trees, and
the vast increase of water moss and other such plants
which, as we have already mentioned, grow in prodi-
gious abundance in all such places. Thus were these
burnt and felled trees buried under a new formed
spongy and watery earth, and afterwards found on the
draining and digging through this earth, or moss, again.

Hence it is not strange that Roman weapons and
Roman coins are found among these buried trees ; and
hence it is that among the buried trees some are found
burnt, some chopped and hewn ; and hence also it is
that the bodies of the trees all lie by their proper roots,
and with their tops lying north-east, that is, in that di-
rection in which a south-west wind would have blown
them

them down : hence also it is, that some of the trees are <sup>Preparation
of Land.</sup> found with their roots lying flat, these being not cut or burned down, but blown up by the roots afterwards when left single ; and it is not wonderful, that such trees as these should have continued to grow even after their fall, and shoot up branches from their sides which might easily grow into high trees. (*Phil. Trans.* N^o 275.)

By this system it is also easily explained why the moor soil in the country is in some places two or three yards thicker than in others, or higher than it was formerly, since the growing up of peat earth or bog ground composed of moss plants is well known, and the soil added by overflowing of waters is not a little.

As the Romans were the destroyers of this great and noble forest, so they were probably also of the several other ancient forests ; the ruins of which furnish us with the bog wood of Staffordshire, Lancashire, Yorkshire, and other counties. But as the Romans were not much in Wales, in the Isle of Man, or in Ireland, it is not to be supposed that forests cut down by these people gave origin to the fossil wood found there ; but though they did not cut down these forests, others did ; and the origin of the bog wood is the same with them and with us. Holinshed informs, that Edward I. being unable to get at the Welsh because of their hiding themselves in boggy woods, gave orders at length that they should all be destroyed by fire and by the axe ; and doubtless the roots and bodies of trees found in Pembrokeshire under ground, are the remains of the execution of this order. The fossil wood in the bogs of the island of Man is doubtless of the same origin, though we have

not

PRACTICE OF

on not any accounts extant of the time or occasion of the forests there being destroyed; but as to the fossil trees of the bogs of Ireland, we are expressly told, that Henry II. when he conquered that country, ordered all the woods to be cut down that grew in the low parts of it, to secure his conquests, by cutting away the places of resort of rebels.

The tendency of our climate to produce in cold and damp situations moss plants, which gradually form around themselves a liquor which is the enemy of all putrefaction, may be considered as a fortunate circumstance, upon the whole, for the preservation of the health of men and animals, as well as contributing to other valuable purposes. In considering the nature of moss, "I cannot dismiss the subject (says Mr Headrick) without suggesting my admiration at the beneficence of Providence, in having provided the moss plants for the situations in which they grow: they afford an immediate supply of fuel, and are the source from which pit-coal derives its origin, though trees, and all the plants which abound in oils and carbon, also contribute to the supply of pit-coal. Were the places now occupied by mosses divested of vegetables, or stored with vegetables of a different character, they would become noisome fens, which, by the emission of putrid gasses, would spread all around them pestilence and death. Mosses emit no noxious gasses, but rather, by growing at the surface, where the plants are acted upon by the sun's rays, they perpetually throw out oxygen, and thus contribute to the salubrity of the atmosphere. The only defect with which they are chargeable is forming magazines of moisture, which by its exhalation generates cold, and spreads rheumatism and inter-

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mitting fevers among all the animals within its reach. Preparation
of Land. The perpetual evaporation of this moisture not only tends to chill the moss, but it descends in hoar-frost and mildews upon all the lands that are lower in point of situation. These last-mentioned disadvantages are more than amply compensated by the consideration that moss is not only an inexhaustible magazine of manure for other soils, but may be converted into a most fertile soil itself. After it is so converted, none of the defects already stated are any longer applicable to it."

This gentleman analyzed chemically some specimens of moss. He found that a small portion of Berkshire peat of great hardness exhibited, when pounded in a mortar and infused in warm water, a liquor that had some slight marks of acidity by test paper. Gypsum and sulphat of magnesia appeared to exist in it. A purified potash produced an abundant precipitation of various substances. A portion of this peat being burned, gave forth at the close of the operation a sulphureous smell and flame. The white ashes, after some days, assumed a rusty colour, from iron contained in them. Being washed, the liquor appeared to contain sulphates of lime, magnesia, alumine, and iron. Black hard peat of Swinridge moor, in Ayrshire, when burned, gave brown ashes which were attracted by the magnet. An infusion of them in water exhibited no mark of acid or of alkali, and the ingredients contained in it appeared to be the same as in the Berkshire peat. Foggy or yellow peat yielded a smaller quantity of ashes, which were white, and did not obey the magnet.

Moss water obtained by squeezing light peats contained gallic acid and tanning principle in great quantities.

~~Preparation~~ ~~tities.~~ Quicklime appeared to be the most powerful agent in precipitating every substance from the moss water, and in rendering moss a compact and solid substance; a fact which, as will be afterwards noticed, has been successfully taken advantage of in practice.

There are two ways in which a tract of territory that is covered by moss may be reduced under the dominion of the plough, or rendered fit for the purposes of agriculture. The one consists of altogether removing the mossy substance, or the whole wrecks of the moss plants that have been accumulating for ages, and endeavouring thereafter to cultivate the subsoil. The other mode consists of converting the substance of the moss into vegetable mould fit for bearing crops of grain.

The first of these plans has been adopted with regard to the moss of Kincardine; and the other has been successfully practised by Mr Smith of Swinridge-muir, in Ayrshire, and in imitation of him by various other persons in different districts of the country. To each of these we shall give attention.

~~Moss of Kincardine removed by human labour.~~ The moss of Kincardine is a remarkable tract of ground in the shire of Perth, in Scotland, which deserves particular notice, both as a topographical curiosity or subject of natural history, and for the information, equally uncommon and important, which it affords, respecting agricultural improvement, and the promotion of industry and population.

The moss of Kincardine is situated in the parish of the same name, comprehended between the rivers Forth and Teith, and in that district of Perthshire called Monteith. The moss begins about a mile above the confluence of these rivers; from thence it extends in length

length about four miles, and from one to two in breadth; Preparation of Land.
and before the commencement of the operations (an account of which is to be given), comprehended near 2000 Scots acres, of which about 1500 belong to the estate of Blair Drummond, the property of the late Lord Kaimes, by his marriage with Mrs Drummond of Blair Drummond.

As moors are not all of the same nature; before entering upon the improvements made in Kincairdine moor, it will be proper to give a short description of that moor, and of the subjacent soil which is the object of those improvements.

The moor lies upon a field of clay, which is a continuation of those rich extensive flats in the neighbourhood of Falkirk and Stirling, distinguished by the name of *carse*s. This clay, which is one uniform homogeneous mass sinking to a great depth, is found near the surface, consists of different colours, and is disposed in layers. The uppermost is gray; the next is reddish; and the lowest, which is the most fertile, is blue. Through the whole mass not a pebble is to be found. The only extraneous bodies it contains are sea-shells, which occur in all the varieties peculiar to the eastern coast of Scotland. They are disposed sometimes in beds, sometimes scattered irregularly at different depths. By attending to these circumstances, it cannot be doubted that the sea has been the means of the whole accumulation, and that it was carried on in a gradual manner by the ordinary ebb and flow of the tide. Upon any other supposition, why should there not have been a congeries of all the different materials that compose the surface of the surrounding heights? But to whatever cause the origin of this accumulation of clay

Preparation may be ascribed, certain it is that no soil whatever is of Land. more favourable to vegetation, or carries more abundant crops of every kind.

The surface of the clay, which, upon the retreat of the sea, had been left in an almost level plane, is everywhere thickly covered with trees, chiefly oak and birch, many of them of a great size. These trees seem to have been the first remarkable produce of the carse; and it is probable they were propagated by dissemination from the surrounding eminences. They are found lying in all directions beside their roots, which still continue firm in the ground in their natural position; and from impressions still visible, it is evident they have been cut with an axe or some similar instrument. For the cutting of wood, the two common purposes are, either to apply it to its proper use, or that the ground it occupies may be cultivated. In the present case, however, neither of these ends had been proposed, since the trees, by being left just as they were cut, were not only entirely lost, but the ground was rendered totally unfit for cultivation. Hence it is evident, that the downfall of this wood must be ascribed to some more extraordinary cause; and to none more probably than to that expedient, which, as we learn from Dion Cassius and other historians, the Romans put so extensively in practice to dislodge from their forests the ancient inhabitants of the British islands, as already explained.

This hypothesis acquires no small degree of force from a circumstance that occurred in May 1768, when a large round vessel of thin brass and curious workmanship, 25 inches in diameter, and 16 inches in height, was discovered upon the surface of the clay buried un-

der the moss. This vessel, found upon the estate of John Ramsay, Esq. of Ochtertyre, was by that gentleman presented to the Antiquarian Society of Edinburgh; in whose museum it remains deposited for preservation. And in a list of the various donations presented to that society, published by them in 1782, it is there denominated a *Roman camp kettle*.

Between the clay and the moss is found a stratum nine inches thick, partly dark brown and partly of a colour approaching to black. This is a vegetable mould, accumulated probably by the plants that covered the ground previous to the growth of the wood, and by leaves from the trees thereafter. The difference of colour must be owing to a difference in the vegetable substances that compose it. The brown mould is highly fertile; the other, especially in a dry season, is very unproductive. The crop that had occupied this mould when the trees were felled is found still entire. It consists chiefly of heath; but several other smaller plants are also very distinguishable.

Immediately above this stratum lies the moss, to the height, upon an average, of seven feet. It is composed of different vegetables arranged in three distinct strata. Of these the first is three feet thick. It is black and heavy, and preferable to the others for the purpose of fuel. It consists of bent grass (*Agrostis*), which seems to have grown up luxuriantly among the trees after they were felled. The second stratum also is three feet thick. It is composed of various kinds of mosses, but principally of bog-moss (*Sphagnum*). It is of a fallow or iron colour, and remarkably elastic. It is commonly called white peat; and for fuel is considered as much inferior to that above mentioned. The third stratum is composed

Preparation posed of heath and a little bent grass, but chiefly of the Land. deciduous parts of the former. It is about a foot thick, and black.

By far the greatest part of the moss in question is, upon an average, full seven feet deep, and has in all probability lain undisturbed since its formation: this is called the *High Moss*. The remainder, called the *Low Moss*, lies to a considerable breadth around the extremities of the high; and is, upon an average, not above three feet in depth, to which it has been reduced by the digging of peats. These are formed of that stratum of the moss only that lies four feet below the surface and downwards; the rest is improper for the purpose, and is thrown aside.

Before the introduction of the plan which is now pursued, two methods chiefly were employed to gain land from the moss. 1st, The surrounding farmers marked off yearly a portion of the low moss next to their arable land, about 15 feet broad. This they removed with carts and spread upon their fields, some acres of which they for that end left unsown. Here it lay till May or June; when, being thoroughly dry, it was burnt to ashes to serve as a manure. By this means they added to their farms about half a rood of land yearly. But this plan proved unsuccessful; for by the repeated application of these ashes, the soil was rendered so loose that the crops generally failed. 2dly, Many farmers were wont to *trench down* the low moss, and to cover it *furrow deep* with clay taken out of the trench. This, though commendable as an attempt to improve, proved likewise an unavailing method; because in a dry season the superficial covering of clay retains so little moisture that the crop commonly fails.

It has been attempted to cover the moss with clay Preparation
brought from the adjacent grounds. But what from Land.
the necessary impoverishment of the ground from which
the clay was carried, and the softness of the moss, this
was soon found to be impracticable.

Draining has also been proposed as another mode of improvement; and it must be acknowledged, that, by means of draining, many mosses have been converted both into arable and meadow grounds, which in the end became interesting improvements. But in a moss, such as that of Kincardine, this method would be ineffectual; as for several feet deep it is of such a nature, that upon being dried, and divided into parts, it would blow with the wind like chaff; and when thrown aside in the operation of digging peats, it lies for years without producing a single vegetable, except only a few plants of sorrel.

Hence it was thought evident, that all attempts to improve this moss must ever prove abortive; and that the object to be had in view was the acquisition of the valuable soil lying underneath; to which end nothing less was requisite than the total removal of the moss.

By the methods above described from 100 to 200 acres of moss had been removed. When the present plan was introduced, there still remained covered with moss from 1300 to 1400 acres of carfe clay—a treasure for which it must be ever interesting to dig.

In the year 1766 Lord Kaines entered into possession of the estate of Blair Drummond. Long before that period he was well acquainted with the moss, and often lamented that no attempt had ever been made to turn it to advantage. Many different plans were now proposed; at length it was resolved to attempt, by means of water

Preparation as the most powerful agent, entirely to sweep off the
of Land.
whole body of moss.

That moss might be floated in water, was abundantly obvious ; but to find water in sufficient quantity was difficult, the only stream at hand being employed to turn a corn mill. Convinced of the superior consequence of dedicating this stream to the purpose of floating off the moss, Lord Kaimes having made an agreement with the tenant who farmed the mill, and the tenants thirled consenting to pay the rent, he immediately threw down the mill, and applied the water to the above purpose.

In order to determine the best manner of conducting the operation, workmen were now employed for a considerable time upon the low moss both by the day and by the piece, to ascertain the expence for which a given quantity of moss could be removed. It was then agreed to operate at a certain rate per acre ; and in this manner several acres were removed.

But this was to be a very expensive process. The ground gained might, indeed, be afterwards let to tenants ; but every acre would require an expenditure from 12l. to 15l. before it could be ready for sowing ; so that the acquisition of the whole, computing it at a medium to be 1350 acres, would sink a capital of nearly 20,000l. sterling.

One other method still remained ; namely, to attempt letting portions of the moss, as it lay, for a term of years sufficient to indemnify tenants for the expences incurred in removing it. For some time both these plans were adopted ; but several reasons made the latter preferable : 1. The quantity of water to be had was small ; and being also uncertain, it was very inconvenient

tenant for an undertaker; neither were there any houses Preparation
near the spot, which occasioned a great loss of time in ~~of Land.~~
going and coming: but when a man should live upon
the spot, then he could be ready to seize every opportunity. 2. The moss was an useless waste. To let it
to tenants would increase the population of the estate,
and afford to a number of industrious people the
means of making to themselves a comfortable liveli-
hood.

In the mean time it was determined, till as many
tenants should be got as could occupy the whole water,
to carry on the work by means of undertakers.

But before proceeding farther, it will be necessary to
describe the manner of applying water to the purpose of
floating the moss.

A stream of water sufficient to turn a common corn-
mill will carry off as much moss as 20 men can throw
into it, provided they be stationed at the distance of
100 yards from each other. The first step is to make
in the clay, alongside of the moss, a drain to convey
the water: and for this operation the carse clay below
the moss is peculiarly favourable, being perfectly free
from stones and all other extraneous substances, and at
the same time, when moist, slippery as soap; so that not
only is it easily dug, but its lubricity greatly facilitates
the progress of the water when loaded with moss.
The dimensions proper for the drain are found to be
two feet for the breadth and the same for the depth.
If smaller, it could not conveniently receive the spade-
fuls of moss; if larger, the water would escape, leav-
ing the moss behind. The drain has an inclination
of one foot in 100 yards; the more regularly this in-
clination is observed throughout, the less will the moss

Preparation be liable to obstructions in its progres with the water.
of Land. The drain being formed, the operator marks off to a convenient extent alongside of it a section of moss, 10 feet broad; the greatest distance from which he can heave his spadeful into the drain. This he repeatedly does till the entire mass be removed down to the clay. He then digs a new drain at the foot of the moss bank, turns the water into it, and proceeds as before, leaving the moss to pursue its course into the river Forth, a receptacle equally convenient and capacious; upon the fortunate situation of which, happily forming for several miles the southern boundary of the estate, without the interposition of any neighbouring proprietor, depended the very existence of the whole operations.

When the moss is entirely removed, the clay is found to be encumbered with the roots of different kinds of trees standing in it as they grew, often very large: their trunks also are frequently found lying beside them. All these the tenants remove, often with great labour. In the course of their operations they purposely leave upon the clay a stratum of moss five inches thick. This, in spring, when the season offers, they reduce to ashes, which in a great measure ensures the first crop. The ground thus cleared is turned over, where the dryness admits, with a plough, and, where too soft, with a spade. A month's exposure to the sun, wind, and frost, reduces the clay to a powder, fitting it for the seed in March and April. A crop of oats is the first, which seldom fails of being plentiful, yielding from eight to ten bolls after one.

In the year 1767 an agreement was made with one tenant for a portion of the low moss. This, as being the

the first step towards the intended plan, was then view-Preparation
ed as a considerable acquisition. The same terms agreed ^{of Land.}
upon with this tenant have ever since been observed
with all the rest. They are as follow :

The tenant holds eight acres of moss by a tack of 38 years ; he is allowed a proper quantity of timber, and two bolls of oatmeal to support him while employed in rearing a house ; the first seven years he pays no rent ; the eighth year he pays one merk Scots ; the ninth year two merks ; and so on with the addition of one merk yearly till the end of the first 19 years ; during the last five years of which he also pays a hen yearly. Upon the commencement of the second 19 years, he begins to pay a yearly rent of 12s. for each acre of land cleared from moss, and 2s. 6d. for each acre not cleared, also two hens yearly : A low rent indeed for so fine a soil ; but no more than a proper reward for his laborious exertions in acquiring it.

In the year 1768 another tenant was settled. These two were tradesmen ; to whom the preference was always given, as having this great advantage to recommend them, that even when deprived of water they need never want employment. The motives that induced these people to become settlers were, 1st, The prospect of an independent establishment for a number of years. 2dly, The moss afforded them great abundance of excellent fuel ; to which was added the comfortable consideration, that, while busied in providing that necessary article, they had the double advantage of promoting, at the same time, the principal object of their settlement.

Notwithstanding these inducements, still settlers offered slowly : to which two circumstances chiefly con-

B b 3 tributed :

Preparation tributed : 1st, The whole farmers surrounding the moss of Land, threw every possible obstruction in their way. 2dly, By people of all denominations the scheme was viewed as a chimerical project, and became a common topic of ridicule. The plan, however, supported itself ; and in the year 1769 five more tenants agreed for eight acres each ; and thus 56 acres of low moss were disposed of. From the progress made by the first settlers, and the addition of these, the obloquy of becoming a moss tenant gradually became less regarded ; so that in the year 1772 two more were added; in 1773, three; and in 1774, one ; in all 13 : which disposed of 104 acres ; all the low moss to which water could then be conveyed. As water is the main spring of the operation, every tenant, besides the attention necessary to his share of the principal stream, collected water by every possible means, making ditches round his portion of the moss, and a reservoir therein to retain it till wanted.

The tenants in the low moss having now begun to raise good crops, in the year 1774 several persons offered to take possessions in the high moss, upon condition that access to it should be rendered practicable. The high moss wanted many advantages that the low possessed. To the low moss, lying contiguous to the surrounding arable lands, the access was tolerably good but from the arable lands the high moss was separated by 300 or 400 yards of the low, which, even to man, affords but indifferent footing, and to horses is altogether impracticable. The low moss is in general only three feet deep ; the high moss is from six to twelve feet in depth.

It will appear at first sight, that without a road or communication

communication the high moss must forever have proved Preparation
unconquerable. Without delay, therefore, a road was ^{of Land.} opened to the breadth of 12 feet, for several hundred yards in length, by floating off the moss down to the clay.

This being effected, and at the same time an opening given to admit water, in the year 1775 twelve tenants agreed for eight acres of high moss each. In consideration of the greater depth of this part of the moss, it was agreed, that during the first 19 years they should pay no rent; but for the second 19 years the terms of agreement were the same as those made with the tenants in the low moss. To the above-mentioned tenants every degree of encouragement was given; as upon their success depended, in a great measure, the disposal of the great quantity of moss still remaining. But their success, however problematical, was such, that next year, 1776, six more took eight acres each; in 1777, one; in 1778, four; in 1779, three; in 1780, one; in 1781, one; in 1782, one:—In all, including those upon the low moss, 42 tenants, occupying 336 acres.

Though for some time the disposal of the high moss went but slowly on, it was not for want of tenants; but the number of operators was already sufficient for the quantity of water; to have added more would evidently have been imprudent.

In the year 1783 Mr Drummond entered into the possession of the estate of Blair Drummond, and went fully into the plan adopted by his predecessor for subduing the moss. At this time there still remained undisposed of about 1000 acres of high moss. As water was the great desideratum, it was determined,

Preparation that to obtain that necessary article neither pains nor
of Land. expence should be wanting. Steps were accordingly
taken to ascertain in what manner it might be procur-
ed to most advantage.

Meanwhile, to prepare for new tenants, a second road parallel to the former, at the distance of half a mile, was immediately begun and cut, with what water could be got, down to the clay, 12 feet broad and 2670 yards long, quite across the moss. This opening was previously necessary, that operators might get a drain formed in the clay to direct the water; and it was to remain as a road that was absolutely necessary, and which relieved settlers from an expence they were unable to support. These preparations, the progress of the former tenants, and the prospect of a farther supply of water, induced 10 more to take possessions in the year 1783: in the year 1784, 18 more took possessions; and in 1785 no fewer than 27:—in all 55 tenants in three years: which disposed of 440 acres more of the high moss.

As the introduction of an additional stream to the moss was to be a work both of nicety and expence, it was necessary to proceed with caution. For this reason several engineers were employed to make surveys and plans of the different modes by which it might be pro-
cured. In one point they all agreed, that the proper source for furnishing that supply was the river Teith, a large and copious stream that passes within a mile of the moss; but various modes were proposed for effect-
ing that purpose.

To carry a stream from the river by a cut or canal into the moss was found to be impracticable; and Mr Whitworth

Whitworth * gave in a plan of a pumping machine, Preparation of Land. which he was of opinion would answer the purpose extremely well.

Soon after this Mr George Meikle of Alloa, a very skilful and ingenious millwright, gave in a model of a wheel for raising water entirely of a new construction, of his own and his father's invention jointly. This machine is so exceedingly simple, and acts in a manner so easy, natural, and uniform, that a common observer is apt to undervalue the invention: But persons skilled in mechanics view machinery with a very different eye; for to them simplicity is the first recommendation a machine can possess. Accordingly, upon seeing the model set to work, Mr Whitworth, with that candour and liberality of mind that generally accompany genius and knowledge, not only gave it the greatest praise, but declared that, for the purpose required, it was superior to the machine recommended by himself, and advised it to be adopted without hesitation.

The better to explain this machine, two sketches are annexed, to the first of which the following letters refer. The explanation of the second will be found upon the sketch.

a, Sluice through which is admitted the water, that Plate XXL moves the wheel.

b, b, Two sluices through which is admitted the water raised by the wheel.

c, c,

* This gentleman was superintendant of the London water works, and an engineer of great reputation in England. He was several years employed in Scotland in completing the great canal.

Preparation of Land. *c, c,* A part of one of two wooden troughs and an aperture in the wall, through which the above water is conveyed into the buckets. [The other trough is hid by two stone walls that support the wheel.]

d, d, d, Buckets, of which 80 are arranged on each side of the arms of the wheel = 160.

e, e, e, A cistern, into which the water raised by the buckets is discharged.

f, f, f, Wooden barrel pipes, through which the water descends from the cistern under ground to avoid the high road from Stirling, and the private approach to the house.

Sketch second contains a plan of the cistern, and exhibits the manner in which the water is filled into the buckets. It will be seen that

The diameter of the wheel to the extremities of the float-boards is 28 feet; the length of the float-boards 16 feet. The wheel makes nearly four revolutions per minute; in which time it discharges into the cistern 40 hogsheads of water. But this is not all the wheel is capable of performing; for by several accurate trials by Messrs. Whitworth and Meikle, in the result of which, though made separately, they perfectly agreed, it was found that the wheel was able to lift no less than 80 hogsheads per minute; but that the diameter of the pipes through which the water descends from the cistern would not admit a greater quantity than what they already receive.

To a person at all conversant in hydraulics, the resemblance of this to the Persian wheel must be obvious; and indeed it is probable, that from the Persian wheel the first idea of this machine was derived. But admitting this, still the superiority of the present wheel is,

In most respects, so conspicuous, as to entitle it to little <sup>Preparation
of Land.</sup> praise than the first invention. For, 1st, In the Persian wheel, the buckets being all moveable, must be constantly going out of order: In this wheel they are all immovable, consequently never can be out of order. 2dly, Instead of lifting the water from the bottom of the fall, as in the Persian wheel, this wheel lifts it from the top of the fall, being from four or five feet higher; by which means some additional power is gained. 3dly, By means of the three sluices (*a*, and *b*, *b*, fig. 1.) in whatever situation the river may be, the quantity of the water to be raised is so nicely adjusted to that of the moving power, as constantly to preserve the wheel in a steady and equable motion. In short, as a regulator is to a watch, so are these sluices to this wheel, whose movements would otherwise be so various, as sometimes to carry the water clear over the cistern, sometimes to drop it entirely behind, but seldom so as fully to discharge the whole contents of the buckets into the cistern.

It is however but candid to remark, that this machine labours under a small defect, which did not escape the observation of Mr Whitworth; namely, that by raising the water about $3\frac{1}{2}$ feet higher than the cistern where it is ultimately delivered, a small degree of power is lost. To this, indeed, he proposed a remedy; but candidly confessed, that as it would render the machine somewhat more complex, and would also increase the friction, he thought it more advisable to keep it in its present state. At the same time he justly observed, that as the stream by which the wheel is moved is at all times copious and powerful, the small loss of power occasioned

Preparation occasioned by the above circumstance was of little or
of Land.
no avail.

This stream is detached from the Teith at the place where that river approaches nearest to the moos. The surface of the latter is about 15 feet higher than that of the former; the cistern is therefore placed 17 feet above the surface of the stream so as to leave a declivity sufficient to deliver the water upon the surface of the moos.

The pipes through which the water descends from the cistern are composed of wooden barrels hooped with iron, 4 feet long and 18 inches in diameter within.

In these pipes, having been conveyed under ground for 354 yards from the cistern, the water at once emerges into an open aqueduct. This aqueduct, which was formed according to a plan by Mr Whitworth, is constructed wholly of earth or clay; and in order to keep the water on a level with the surface of the moos, it is for nearly two thirds of its course elevated from 8 to 10 feet above the level of the adjacent grounds; the base being 40 feet broad, the summit 18 feet, and the water course 10 feet broad. It commences at the termination of the pipes; from whence extending above 1400 yards, it discharges the water into a canal formed for its reception on the surface of the moos.

For raising the water to this height, there were two reasons: 1st, That not only where it was delivered on the moos, but even after being conveyed to the most distant corners, it might still retain sufficient power to transport the moos to the river Forth. 2dly, That reservoirs of a sufficient height might be formed in the moos to retain the water delivered during the night.

In consequence of Mr Whitworth's advice, a contract

tract was entered into with Mr Meikle in spring 1787 ; Preparation
and by the end of October in that year, the wheel, ^{of Land.}
pipes, and aqueduct, were all completely finished ; and
what, in so complex and extensive an undertaking, is
by no means common, the different branches of the
work were so completely executed, and so happily ad-
justed to each other, that upon trial the effect answered
the most sanguine expectations. The total expence ex-
ceeded 1000l. sterling.

To induce the proprietor to embark in this under-
taking, the moss tenants had of their own accord pre-
viously come under a formal engagement to pay the
interest of any sum that might be expended in procur-
ing a supply of water. But he was determined they
should not enjoy by halves the sweets of this long
wished for acquisition. With a view, therefore, not
only to reward their past industry, but to rouse them
to future exertions, he at once set them free from
their engagement ; nor has any interest ever been de-
manded.

This new supply was a most acceptable boon to the
moss tenants. In order to make an equitable distribu-
tion, the water raised through the day was allotted
to one division of operators ; that raised during the
night to another. To retain the latter, a canal was
formed, extending almost three miles through the cen-
tre of the moss. From place to place along the sides
are inserted sluices to admit water to the reservoirs of
the possessors ; each sluice having an aperture propor-
tioned to the number of operators to be supplied from
the reservoir which it fills. For the water raised through
the day no reservoirs are necessary ; as it is immediate-
ly used by the division to which it is allotted.

This

Preparation of Land. This additional stream, though highly beneficial, yet is not more than sufficient to keep 40 men at constant work. But such a quantity as would give constant work is not necessary: the operators must be often employed in making and repairing their drains, grubbing up roots of trees, &c.; so that a quantity sufficient to give five or six hours work per day to the whole inhabitants is as much as would be wanted. But as the quantity procured was still insufficient for this purpose, a small stream that descended from the higher grounds was diverted from its course and brought into the moss. From want of level this stream could not be delivered to the greatest advantage; namely, upon the surface of the moss. Yet by making, at a considerable expence, a drain half a mile long, and a reservoir for the night water, it was rendered of much importance: and during the whole winter months, as well as in summer, after every fall of rain, it kept 15 persons fully employed.

In the year 1787, two more tenants agreed for eight acres each; in 1788, four; in 1789, eight; in 1790, four tenants, all agreed for the same number of acres.

The whole moss was now disposed of, except that part called *Flow Moss*, which comprehends about 400 acres. Here it is twice the usual breadth, so fluid that a pole may be thrust with one hand to the bottom; and the interior part, for near a mile broad, is three feet above the level of all the rest of the moss. Hitherto the many and various difficulties that presented themselves had been overcome by perseverance and expence. But here the extraordinary elevation of the mosses, joined to its great fluidity, seemed to exclude

all

all possibility of admitting a stream of water; and Preparation
it was the general opinion that the moss operations ^{of Land.} had now arrived at their *ne plus ultra*, and that this morass was doomed to remain a nuisance for ages to come.

But the proprietor had now advanced so far that he could not submit to retreat: and he considered himself as, in some measure, pledged to the country for the completion of this undertaking. To detail the various methods practised to introduce a stream of water into that morass, would prove tedious. It is sufficient to say, that after a thousand unsuccessful efforts, attended with much trouble and considerable expence, the point at last was gained, and a stream of water was brought in, and carried fairly across the centre of the morass.

The greatest obstacle was now indeed overcome; but still another remained of no small moment, namely, the discouragement given to settlers from the total impossibility of erecting habitations upon the surface of this morass. To find a remedy for this evil was difficult. Happily a resource at last occurred. This was to bargain with a certain number of the old tenants, whose habitations were nearest, to take leafes of portions of the morass. But as some additional aid was here necessary, it was agreed that 12l. sterling should be gradually advanced to each tenant till he should accomplish the clearing of an acre, for which he or his successor is bound to pay 12s. of yearly rent, equal to five per cent. upon the sum advanced. When this point shall be gained, they are bound to dispose, as most agreeable to themselves, either of their old or of their new

Preparation new possession ; for which, when once an acre is cleared of Land, purchasers will not be wanting.

In consequence of the above arrangement, during the year 1791 no fewer than 35 of the old tenants agreed, upon the foreaid conditions, for eight acres each of the flow moss. Thus 1200 acres are now disposed of to 115 tenants. But when these 35 tenants shall each have cleared their acre, then, according to agreement, 35 additional tenants will speedily be acquired ; and the moss will then contain in all 150 families.

To the leases at first granted to the tenants in the high moss, it was afterwards determined to add a further period of 19 years (making in all 57 years), during which they are to pay one guinea per acre ; a rent not greater than the land is worth even at present, but greatly below its probable value at that distant period. This, it is hoped, will prove to the tenants a sufficient incitement to continue their operations till their possessions are completely cleared from moss.

Having now gone through, in detail, the whole progress of the colony for many years after its first settlement in the year 1767, it still remains to take a general view of the effects produced by that establishment.

For several years, at first, the water was used chiefly to carry off moss, in the forming of new roads, and preparing reservoirs ; which considerably retarded the principal object, of gaining land. Nevertheless there have been cleared full 300 acres of excellent land, producing wheat, barley, oats, and clover, yielding from six to twelve bolls after one.

From the nature of the undertaking, there is good reason to suppose that the operations will yearly advance

vance with greater rapidity ; especially as the greater Preparation of Land. number of the settlers have only of late begun to operate. Many, besides maintaining their families otherwise by occasional employments, have in the high moss cleared in a year one rood of land ; some have cleared two, some three roods, and in the low moss an acre.

It was a remark often made, even by persons of some observation, that by collecting together such a number of people, Kincardine would be overstocked ; and the consequence would be their becoming a burden on the parish : for as the bulk of them were labourers not bred to any trade, and possessed of little stock, it was foreseen, that, for some time, they could not afford to confine themselves solely to the moss, from which the return must be slow ; but behoved, for immediate subsistence, to work for daily hire. Happily these predictions have proved entirely groundless ; for such is the growing demand for hands in this country, that not only do the whole of these people find employment whenever they choose to look for it, but their wages have been yearly increasing from the time of their first establishment. In short, they have proved to the corner where they are set down a most useful nursery of labourers ; and those very farmers who, at first, so strongly opposed their settlement, now fly to them as a sure resource for every purpose of agriculture. Still they consider the moss operations as their principal business ; none pay them so well ; and when they do leave it to earn a little money, they return with cheerfulness to their proper employment. Many of them already raise large quantities of grain, and have no occasion to go off to other work ; which will soon be

Preparation the case with the whole. Their original stock, indeed, of Land did not often exceed 25l. and some had not even 10l.; but what was wanting in stock was compensated by industry.

Of the whole inhabitants full nine-tenths are Highlanders, from the neighbouring parishes of Callander, Balquhidder, &c.; a sober, frugal, and industrious people, who, inured to hardships in their own country, are peculiarly qualified to encounter so arduous an undertaking. From this circumstance, too, arises a very happy consequence; that wearing a different garb and speaking a different language from the people amongst whom they are settled, they consider themselves in a manner as one family transported to a foreign land: and hence upon all occasions of difficulty, they fly with alacrity to each others relief. Neither ought it to be forgotten, that, from their first settlement to the present day, not a single instance has occurred amongst them of theft, bad neighbourhood, or of any other misdemeanour, that required the interposition of the civil magistrate. Nor, however poor in circumstances, has any one of them ever stooped to solicit assistance from the funds of the parish appropriated to that purpose.

Though few of the tenants entered with a large stock, one only has been obliged to leave the moss from incapacity to proceed. Many indeed have spent their small stocks, and even run a little in debt: but in this case they have been permitted to sell their tacks upon the following conditions: 1st, That the purchaser shall be a good man; 2dly, That the seller shall take another possession. By this manoeuvre a new inhabitant is gained; while the old one, relieved from debt, and

and aided by past experience, recommences his operations with double spirit upon a new possession. The monied man again has at once a house and a piece of ground, the want of which chiefly startled new beginners.

Some have even made a kind of trade of selling ; infomuch, that from the year 1774 to the year 1792, no fewer than fifty sales took place, producing in all the sum of 849l. sterling. This proved from time to time a most seasonable recruit to the colony, and gave new vigour and spirits to the whole.

The number of the settlers is productive of an excellent effect ; that although some are generally absent, enough still remain to occupy the water constantly. In a favourable day, there may be seen hundreds, men, women, and children, labouring with the utmost assiduity. The women declare they can make more by working at the moss than at their wheel ; and such is the general attachment to that employment, that they have frequently been discovered working by moonlight.

Another happy consequence arising from their numbers is the great quantity of moss they consume for fuel. There are in all 115 families. Each family requires at an average 10 dargues * of peats yearly. Each dargue uncovers a space equal to 10 square yards of clay : so that, by casting peats, the moss tenants gain yearly about 6 roods of land.

The advantage, too, of providing their fuel with so little trouble, is very great. They require yearly 1150

C c 2

dargues

* A dargue (or darg) of peats, is the quantity that one man can cast and two can wheel in a day to the field where they are spread out to dry.

PRACTICE OF

Land
Largues of peats; which, as each dargue when dried
and stacked is valued at five shillings, are worth 287.
10s. sterling; a sum which otherwise must have been
expended on the prime cost and carriage of coals.—
Many of them cast peats for sale; and 100l. worth are
yearly disposed of in the town of Stirling, the village of
Dove, &c.

Though moss work be laborious, it is at the same time amusing. The operator moves the moss five feet only at a medium; and the water, like carts in other cases, carrying it off as fast as it is thrown in, excites him to activity. Still he must submit to be wet from morning to night. But habit reconciles him to this inconvenience; while his house and arable land fill his eye and cheer his mind. Nor is it found that the health of the inhabitants is in the smallest degree injured either by the nature of the work or the vicinity of the moss.

The quantity of moss that one man can move in a day is surprising; when he meets with no interruption, seldom less than 48 cubic yards, each weighing 90 stones. The weight, then, of moss moved per day is— no less than 4320 stones. A cubic yard is moved into the water, and of course carried into the river Forth— for one farthing. It follows, that the expence of moving 48 cubic yards is one shilling. But the same quantity moved to the same distance by carts would cost 2— shillings. Hence the advantage derived from the possibility of floating moss in water, and the great importance of having water for that purpose.

The moss, when contrasted with the rich lands surrounding, appeared, especially before the improvements, a very dreary spot; one wide unvaried wil^l,
total ly

totally unproductive, unfit even to furnish sustenance Preparation
to any animal, except here and there a few wretched ~~Land.~~
straggling sheep. Besides, it entirely cut off all con-
nection betwixt the farms on either side; among which,
no intercourse was practicable but by a circuit of sev-
eral miles.

The scene was soon greatly changed. The following are the numbers of the inhabitants who some years ago resided in the moss; also of their cows and horses, and of the acres gained by them from the moss, together with their produce.

Men	-	-	115
Women	-	-	113
Boys	-	-	199
Girls	-	-	193
		Total	620
Number of cows, at least,	-		115
Ditto of horses and carts	-	-	34
Ditto of acres cleared from moss	-		300

The produce in bolls cannot be exactly ascertained: but, considering the goodness of the soil, may be fairly stated at eight bolls per acre. *Inde* 2400 bolls.

As oats are the staple commodity, the calculation shall be confined to that grain. According to the fairs of Stirlingshire, crop 1790, carse oats are valued at 14s. per boll. *Inde* 2400 bolls at 14s. is 1680l. Of late this price has at times been doubled.

A tract of ground so considerable, formerly a nuisance to the country, thus converted into a fertile field filled with inhabitants, comfortable and happy, cannot surely be surveyed with an eye of indifference by any person

Preparation person whose mind is at all susceptible of feeling or of
of Land. public spirit.

An excellent gravelled road, 20 feet wide and a mile and a half long, is now carried quite across the moss. By this means, in the first place, a short and easy intercourse is established between two considerable parts of the estate, formerly as little connected as if separated by a lake or an arm of the sea. Secondly, The inhabitants of the moss, to whom, hitherto, all passage with carts or horses was impracticable for at least one half of the year, have now obtained the essential advantage of being able, with ease, to transport all the different commodities at every season of the year. This road was entirely formed by the hands of the moss tenants, and gravelled by their own carts and horses: a work which, it will not be doubted, they performed with much alacrity; when it is considered that, to the prospect of procuring a lasting and material benefit to themselves, there was joined the additional inducement of receiving an immediate supply of money, the whole being done at the proprietor's expence.

The possessions are laid off in the manner best fitted for the operations; and are divided by lanes running in straight lines parallel to each other. Parallel to these again the drains are carried; and this straight direction greatly facilitates the progress of the water with its load of moss. Upon the bank of moss fronting the lanes, the operation of floating is begun; and twenty or thirty people have been sometimes seen heaving moss into the same drain. That the water might be the more conveniently applied, the lanes include between them the breadth of two possessions only. The new houses are erected upon each

each side of these lanes at the distance of 100 yards Preparation
from each other. of Land.

Before the formation of lanes and roads, and while yet no ground was cleared, the first settlers were obliged to erect their houses upon the surface of the moss. Its softness denied all access to stones; which, at any rate, are at such a distance as would render them too expensive. Settlers, therefore, were obliged to construct their houses of other materials. Upon the low moss there is found for this purpose great plenty of sod or turf, which accordingly the tenants use for the walls of their houses. For the rudeness of the fabric nature in some measure compensates, by overspreading the outside with a luxuriant coating of heath and other moorish plants, which have a very picturesque appearance.

But upon the high moss there is no sod to be found. There the tenant must go differently to work. Having chosen a proper situation for his house, he first digs four trenches down to the clay, so as to separate from the rest of the moss a solid mass, containing an oblong rectangular area, sufficiently large for his intended house. This being done, he then scoops out the middle of the mass, leaving on all sides the thickness of three feet for walls; over which he throws a roof, such as that by which other cottages are commonly covered.

Upon the softest parts of the moss, even these walls cannot be obtained. In such places the houses are built with peat dug out of the moss, and closely compressed together while in a humid state *. It is necessary

* This does not apply to the morass, upon the surface of which, it has already been observed, it is impossible to erect houses in any shape.

Preparation sary even to lay upon the surface a platform of boards of Land. to prevent the walls from sinking; which they have frequently done when that precaution was neglected. After all, to stamp with the foot will shake the whole fabric as well as the moss for fifty yards around. This, at first, startled the people a good deal; but custom soon rendered it familiar.

The colonists have now made considerable advancement in rearing better habitations for their comfort and convenience. Their huts of turf are but temporary lodgings. As soon as they have cleared a little ground, they build houses of brick: when the proprietor a second time furnishes them with timber gratis. It has also been found necessary to relieve them entirely from the payment of the burdensome tax upon bricks; a tax which surely was never intended to fall on such poor industrious adventurers; and which, without this assistance, would have proved a most effectual bar to the employment of these materials.

There are now erected in the moss 69 brick houses, substantially built with lime. The total expence amounted to 1033l. sterling. And it is a very comfortable circumstance, that the money expended upon these houses is mostly kept in circulation among the inhabitants themselves; for as a number of them have learned not only to manufacture but also to build bricks, and as others who have horses and carts furnish the carriage of lime and coals, they thus interchange services with each other.

With a view to excite the exertion of the colonist, the following premiums were also offered: 1. To the person who shall in the space of one year remove the greatest quantity of moss down to the clay, a plough,

of the best construction. 2. To the person who shall Preparation
remove the next greatest quantity, a pair of harrows of Land.
the best kind. 3. For the next greatest quantity, a
spade of the best kind, and 10lb. of red clover seed.
But as these premiums, if contested for by the whole in-
habitants, could reach but a very few of the number,
they were therefore divided into six districts according
to their situation ; and the above premiums were offered
to each district.

The establishment of this colony was no doubt at-
tended with a very considerable share of expence and
difficulty ; for the undertaking was altogether new,
and there were many prejudices against it, which it
was necessary to overcome. At the same time it was
noble and interesting : it was to make a valuable addi-
tion to private property : it was to increase the popu-
lation of the country, and to give bread to a number
of people ; many of whom having been turned out of
their farms and cottaries in the Highlands, might other-
wise, by emigration, have been lost to their country ;
and that too at a time when, owing to the great en-
largement of farms, depopulation prevails but too
much even in the low countries. And it was to add
to the arable lands of the kingdom, making many
thousand bolls of grain to grow where none ever grew
before.

These considerations have hitherto preponderated
with the proprietors against the various obstacles that
present themselves to the execution of so extensive an
undertaking. Should their example tend in any de-
gree to stimulate others, who both in Scotland and in
England possess much ground equally useless to the
country, to commence similar improvements, it would
be

Preparation be a most grateful consideration superadded to the
of Land. pleasure already arising from the progress of the infant
colony.

On account of the importance of the subject, we have here inserted the above detail, which was written some years ago, of the improvements carried on in the mosses of Kincardine, commonly called *Moss Flanders*. But after all, it will probably hereafter be thought, that the great efforts of ingenuity, and of persevering industry, which were requisite in the above operation, might all have been avoided, and the work much easier performed, had the art been found out of converting moss into fruitful soil, according to the plan practised, and undoubtedly brought to great perfection in Ayrshire, by the gentleman already mentioned, John Smith, Mr Smith's Esq. of Swinridge muir, near Beith. On a part of a moss in this gentleman's property, a quantity of lime had been spread in consequence of the miring of some carts in wet weather; to relieve which, their load was laid over the ground in their neighbourhood, though this was accounted at that period an absurd operation, as it was believed that lime would have the effect of consuming and rendering mossy ground useless for ever. The proprietor, Mr Smith, was then in the army, towards the close of the American war. On returning home the succeeding summer, and being informed of the accident, he was surprised to find that as good a crop grew upon the patch of moss on which the lime had been scattered, as upon another spot that had been pared and burned, in consequence of instructions that he had transmitted home for that purpose, from having perused some treatises in which burning of moss was recommended. He also remarked, that upon the places which

which had neither been burned nor limed, nothing Preparation
grew, and that the crop upon the burned soil was inferior to that where the lime had been laid, being almost choked with sorrel. Mr Smith pursued the hint thus obtained: He reclaimed by means of lime every portion of moss in his own possession, and having satisfied his tenants of the utility of the practice, he allowed them to dig limestone gratis, and gave them the refuse of his coal at prime cost to burn it. Thus, in a short time, every part of the moss upon his estate was reduced under cultivation, and rendered highly valuable.

When Mr Smith began his operations, he met the fate of innovators in agriculture, that is, he was ridiculed by all his neighbours. His success, however, at length made some converts, and though the new system at first advanced slowly, it was at last universally approved of, and extensively imitated. The result has been, that what was once the worst land in the country, is now become the most productive and fertile.

The following is a concise statement of Mr Smith's practice, and consequently of the Ayrshire practice, of actually converting moss into vegetable mould, capable of bearing rich crops of corn, hay, potatoes, &c. which we shall give in the words of Mr Headrick *.

" 1. When they enter upon the improvement of a moss in its natural state, the first thing to be done is, to mark and cut main or master drains, eight feet in width, by four and a half in depth, and declining to two and a half at bottom; these cost 1s. per fall of six Scots ells. In some instances, it will be found necessary

* *Communications to the Board of Agriculture*, vol. ii.

Preparation necessary to cut those drains much deeper, consequently ~~at least~~ at a greater expence. These drains almost in every instance can be, and are so conducted, as to divide the field into regular and proper enclosures. They always make it a rule to finish off as much of a drain as they have broken up, before they leave it at night; because, if a part is left dug, suppose half way, the oozing of water from the sides would render the bottom so soft, that they could neither stand upon it nor lift it with the spade. When the moss is so very soft, that the pressure of what is thrown out of the drain may cause its sides to fall in again, they throw the clods from the drain a considerable way back, and sometimes have a man to throw them still further back, by a spade or the hand; for this reason too, they always throw the stuff taken from a drain as equally as possible on each side of it. In digging the drains, the workmen stand upon small boards to prevent them from sinking, and move them forward as the work advances.

“ When the moss lies in a hollow, with only one outlet, it is necessary to lead up a drain, so as to let the water pass this outlet, and then conduct it along the lowest or wettest part of the moss: this middle drain is afterwards sloped, and the stuff thrown back into the hollows that may occur; upon it the ridges are made to terminate on each side, while a ring drain, serving the purpose of a fence, is thrown round the moss at the line where the rising ground commences. This can generally be so managed as to divide the moss into a square field, leaving straight lines for the sides of the contiguous fields. The ring drain intercepts the surface water from the higher grounds, and conducts it into the lower part of the outlet, while the sloped drain

in the centre receives and discharges all the water that Preparation
falls upon the moss.

After the moss collapses in consequence of liming and culture, it is often necessary to clean out these drains a second time, and to dig them to a greater depth: their sides become at last like a wall of peat, which few animals will venture to pass.

" 2. The drains being thus completed, they mark out the ridges, either with a long string or with three poles set in a line. Mr Smith has tried several breadths of ridges, but now gives a decided preference to those that are seven yards in breadth. The ridges are formed with the spade in the following manner: In the centre of each intended ridge, a space of about two feet is allowed to remain untouched; on each side of that space a furrow is opened, which is turned over so as completely to cover that space, like what is called *veering* or *feathering* of a gathered ridge; the work, thus begun, is continued by cutting furrows with the spade, and turning them over from end to end of the ridge on each side, until they arrive at the division furrows. The breadth of the slices thus cut, may be about 12 inches, and each piece is made as long as it may suit to turn over: the ridge when finished, has the appearance of having been done with a plough. The division furrow is two feet in breadth, which if necessary to draw off superfluous water, is partly cut and thrown upon the sides, or into hollows in the ridges on each side. The depth of the division furrows is regulated by circumstances so as not to lay the ridges at first too dry, but at the same time, to bleed, as it were, the moss, and conduct the superfluous water into the master drains.

" 3. The next operation is to top-dress the ridges with

~~Preparation~~ ^{of Land} with lime. The sooner this is done after the ridges are formed, the better. When the moss appears dry, experienced farmers throw on the lime, but do not clean out the division furrows until the ensuing winter. When it is soaked in water, they clean the division furrows as soon as the lime is ready, and after the water has run off apply the lime immediately. It is of great importance to have the lime applied while the moss is still moist, and the lime in as caustic a state as possible. For this purpose, they have the lime conveyed from the kiln in parcels, flaked and laid on as fast as the ridges are formed. Being dropped from carts, and flaked at the nearest accessible station, it is carried to the moss by two men on light handbarrows, having a hopper and bottom of thin boards, and there spread with shovels as equally as possible. During the first and second years, the crop is generally carried off in the same way. In some places where a moss is covered with coarse herbage, and accessible by carts in dry weather, I saw them give a good dose of lime to the moss before it was turned up with the spade, and another after the ridges were formed. It is surprising how quickly they execute these operations with the handbarrows. In other places where coarse boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

"The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much less sparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppose 120 bolls, or 480 Winchester bushels, of flaked or powdered lime allowed

to every Scots acre, this would cost at the sale kilns Preparation
40s.; and thus the reader may be enabled to calculate of Land.
the expence of lime in this district at every given proportion: But most of the farmers here burn lime for themselves in vast kilns of sod, and think they have it much cheaper than it could be got from a sale kiln. In many places, limestone abounds so much, that houses, fences, and roads are constructed with it; and when a farmer burns the limestone within his premises, he at least saves the expence of carriage.

" In some cases, after the limestone is laid on, they go over the ground with hoes, or with spades, hacking and mangling the clods, and mixing the lime more completely with the superficial soil; but where there is much to do, and hands are scarce, they never think of these operations.

" 4. The field thus prepared is ready to receive the seed, which is sown at the proper season whether it be *wet* or *dry*, and harrowed in with a small harrow drawn by two men. Four men will with ease harrow at least five or six rods per day, two and two dragging the harrow by turns, and two breaking and dividing the mould with spades. When the lime has been applied early the preceding summer, a good crop of oats may generally be expected; but if it has been recently applied, the first crop of oats frequently misgives, as the lime has not time to combine with the moss, and form it into a soil.

" The early Dutch or Polish oats are always preferred by moss improvers, as the common Scots or late oats are too apt to run into straw, and lodge before the grain arrives at maturity. The same proportion of seed is allowed per acre that is usual in other places.

The

Preparation The great desideratum is, to procure plants which will
of Land. throw up a sufficient quantity of herbage, so as to shield
the surface from the winds and sun's rays, and thus to
keep it moist during the first summer after a moss is
reclaimed.

This desideratum is effectually supplied by the potato, which thrives well on moss at all times, whether recently opened up and limed, or at any future period of its cultivation ; only it requires a proportion of stable dung. It is now become the general practice in Ayrshire, to plant potatoes on those mottes which have been but recently turned up and limed ; and where dung can be procured, it is generally the first crop on all their mottes.

“ The method of planting potatoes, whether they be the first crop or succeed the first crop of oats, is by lazy beds. If they be the first crop, the moss having been delved into ridges, and limed as before directed, spaces of from five to six feet in breadth are marked out across the ridges, having intervals of about two feet, from which the moss is taken to cover the sets. These spaces or beds are covered over with a thin *stratum* of dung, laid upon the surface of the lime at the rate of about sixteen tons to the Scots acre. The cuttings of the potatoes are laid or placed upon the said beds, about ten or twelve inches asunder ; and the whole are covered over with moss, taken from the intervals which are thus converted into ditches, to be followed by another covering about the time the potato plants begin to make their appearance, the covering in the whole amounting to about four or five inches ; at the same time the division furrows are cleaned out to cover the sets that are contiguous to them.

The

The whole field is thus divided into spaces or lazy beds, Preparation of Land. like a chequered board. During summer, they cut the moss with hoes, and draw it up a little towards the stems of the plants. Few weeds appear, except what are conveyed by the dung. This is the practice universally followed when potatoes are planted on moss for the first time; but after the moss is finely pulverized and reduced, they either plant them in rows across the ridges, or plant and dress them with the plough in the usual manner.

"Potatoes planted as the first crop never misgive, and they are the best and most certain method at once to reclaim a moss, not owing so much perhaps to the dung aiding the putrid fermentation which the lime has already excited, as to their roots pushing and dividing the moss, while their leaves shelter it from the sun, cause a stagnation of air, and thus keep it in that degree of moisture which is most favourable to the action of lime upon moss. The practice of making potatoes the first crop is now universally followed, in so far as the farmers can command dung. The produce is from 40 to 60 bolls per acre, the potato measure being eight Winchester bushels a little heaped to the boll. Mosses that are fully reclaimed yield from 60 to 70 bolls of potatoes at an average, and in some places where manures are abundant, they have been known to yield from 80 to 100 bolls per acre, of the above measure.

"Mr Smith is about to try yams upon his mosses, from the opinion that prevails among some of the Mid-Lothian farmers, where this plant is much cultivated, that they require little or no dung, and that the superior breadth of their leaves will prove more favourable than those of potatoes, for sheltering the ground.

Preparation of Land. “ When the potato crop is removed, the ridges are again put into their original form ; in doing which, care is taken to preserve the mould that is acquired uppermost ; this is done by moving the subfurrow on each side with a strong spade, half way into the intermediate ditch from which the lazy beds were covered, and scattering the mould equally over the whole surface. This operation costs 18s. per acre. It is not easy to calculate the expence of planting the potatoes, forming the lazy beds, &c. as this is seldom executed by contract ; but the lazy beds being thus reduced, the land is ready for a crop of corn.

“ Though a crop of oats frequently misgives upon moss that has been but recently limed, yet in other cases, when the lime has lain several months upon the land, it proves a good crop, and is sufficient to cover all the expence with a little profit. The crops of succeeding years are sufficient to afford from their straw putrescent manure for such land in order that it may be cleaned with potatoes, and prepared for grafts seeds.

“ But after potatoes of the first year, with the slight operation of reducing the lazy beds, from 10 to 12 bolls of oats are at an average produced per acre. The oats are excellent, and yield from 18 to 20 pecks of meal per boll ; they would sell upon the ground for 10l. or 12l. per acre. The ground continues to yield oats of the same quality for several years, without any apparent diminution of fertility, and without receiving any additional manure : the only apparent bar to the continuance of this crop is, the soil becoming grassy. When the grafts begins to contend with the crop for pre-eminence, the land is thrown into pasture, and would let ever af-

ter

ter in that state at from 20s. to 25s. per acre. Daisies, Preparation of Land. white clover, &c. &c. now spring up in mosses, where their existence was never before suspected ; at the same time, thistles and other weeds for some time infest the pasture.

“ The better practice is, to take another crop of potatoes with a little dung and lime, and give it a trench-delving, to bury the weeds and bring up new soil ; after the potatoes to sow barley and grass seeds.

“ Rye-grass is universally sown here, and it attains amazing perfection upon moss properly prepared ; along with this, white and yellow clover are sometimes sown, and thrive remarkably well. Red clover has been tried, but did not succeed, and is hence discredited for moss-lands : perhaps it may have been unjustly censured, because it is certain that the seasons in which it was tried, proved very unfavourable to red clover in all parts of the country, most of it having died during winter.

“ 5. We have already described the levelling of the lazy beds. All future delvings of the moss are performed from one end of the ridge to the other ; by this method the slices that had been cut and turned over in the first operation of forming the ridge, are again cut across, and constantly reduced into smaller pieces, till they moulder into earth.

“ The expence of delving a moss for the first time, where the surface is tolerably smooth, is 2*½*d. per fall, or 1l. 13s. 4d. per Scots acre ; but where inequalities occur, which must be thrown down by the spade into hollows, it costs about 2l. per acre. If there be eminences, which must be removed into hollows by wheel-barrows running upon boards, the first expence is great-

Preparation according to circumstances. The second delving, where potatoes have not intervened, costs from 1l. to 1l. 6s. per Scots acre, the division furrows being at the same time cleaned out. The third delving and cleaning of the division furrows costs 1l. per acre; but the moss is now so friable, that it may be wrought with the greatest ease and rapidity. At the above rates, an ordinary workman will earn 1s. 6d. per day, and an able and experienced one, from that to 2s. 6d. per day. They use a strong spade, edged with steel, and have always a gritstone near them for sharpening the spade. In the evenings they repair its edge upon a grindstone; and when the steel is worn away, they lay it again with new steel. Sometimes the moss is so soft that they walk upon boards while they are turning it over.

“ Mr Smith has found, by long experience, that it is improper to make the ridges too high or too narrow: when they are too high, they throw the water off from their sides without admitting it to penetrate their substance; the top of course gets too dry: when too narrow, there is a loss of surface from too many division furrows. The breadth already mentioned is found to be the best: and when the improvement is completed, the ridges appear like segments of wide circles, with a clean well-defined division furrow between each of them. The moisture is thus caused slowly to filtrate through the moss rendered friable by lime until it reaches the division furrows, and is discharged. As the moss subsides for some time, and closes in towards the furrows, it is generally necessary to clean these out before winter, and at the time the crop is sown, until the moss acquire solidity.

“ Some mosses may be ploughed the second year to within

within two bouts or four slices of the division furrows, Preparation
and every operation performed by the force of horses, of Land.
except turning over with the spade the narrow stripes
next to the division furrows. In other mosses it re-
quires three years before this can be done; and it sel-
dom happens but every moss may be wrought by the
plough after it has been wrought four years by the
spade. When moss is wrought by the spade, it seems
of no consequence whether it be wrought wet or dry;
but when it is wrought by the plough, opportunities
must be watched, as horses cannot walk upon it for
some years during wet weather.

“ 6. With respect to the quality of the potatoes thus produced upon mosses, I do not scruple to pronounce it most excellent. Potatoes have been tried with dung alone; but they are always watery, and frequently hollow or rotten in the heart: those raised upon mosses that have been well limed, are frequently so dry and farinaceous, that it is difficult to boil them without re-
ducing them to powder; and they are often obliged to lift them with spoons: they come clean out of the ground; keep remarkably well in heaps covered with moss in the field; and are remarkably well fla-
voured.

“ No such disease as the curl was ever known among moss potatoes; and, indeed, if Dr Coventry’s opinion be true, that the curl is caused by overloading the sets with too much earth, or from the earth becoming too hard around them; no such thing can take place in moss. But to whatever cause the curl may be owing, it is certainly propagated by diseased seed; it would, therefore, appear advantageous to transfer the potatoes raised upon moss as seed for solid land. They have a

Preparation remarkably good species of potato in this district, which
of Land. was brought from Virginia to Largs about eight years ago ; and whether it be owing to the beneficial nature of a mossy soil, or to its own intrinsic merits, this potato has long been so much distinguished by the good quality and large quantity of its produce, that it has superseded the use of every other species. There seems to be no occasion for moss improvers to change their seed. Some persons in this district, who have but small patches of moss, have kept them constantly in potatoes more than ten years, without changing the seed, and without any sensible diminution either in the quantity or quality of the crop."

4. *Of bringing Land into Culture from a State of Nature.*

Before attempting to bring under cultivation land that has hitherto remained in a totally rude state, the first consideration with a prudent man ought undoubtedly to be, how far he is able to support the expence of the undertaking. If conducted with skill, it will in almost all practicable cases pay well ; but a stout capital is necessary, because, if only half measures are followed, the whole expence is apt to be lost. This remark, however, is only made with regard to enterprises made upon a great scale ; for small portions, especially of a dry moorish soil, may undoubtedly be improved by neighbouring farmers at a moderate cost.

The first step to be taken towards the improvement of waste lands is, to drain them from all such wetness as might have a tendency to injure their fertility when brought into a state of cultivation. There are few instances of waste lands, especially in the neighbourhood of hills, in which some degree of draining is not requisite.

fite. Till proper drains are formed and completed, it Preparation
is impossible for an improver to form a correct plan for Land.
directing his future procedure, because it frequently
happens that the wetness of a soil, especially at the foot
of mountains, is occasioned by very powerful springs,
which, if let out or tapped by a skilful mode of drain-
ing, and their waters united into a common current,
might form a stream of considerable importance. In
all such cases, such a stream ought to be used for the
purpose of flooding or watering the inferior lands. The
plough ought to be abstained from, and no farther or
more expensive improvement adopted upon these lower
grounds. The important art of flooding lands, or of
irrigation, will be afterwards explained. In the mean
time, it may be here remarked, that there is scarcely a
piece of waste territory in this country which does not
contain spontaneous proofs of the value of irrigation.
We everywhere see firm spots by the sides of torrents,
which from temporary flooding acquire a beautiful ver-
dure that proves a remarkable contrast to the dreariness
of the surrounding waste; and wherever little rills are
found not considerable enough to cut a regular bed for
their waters, but which spread at times over the moun-
tains sides, we observe their course universally marked
by a track of green, in consequence of the destruction of
the heath in these spots by the temporary overflowing
of the water. Wherever by any means a stream can in
like manner be made to overflow at times, or to spread
itself abroad upon the whole surface of the ground, the
heath and coarser plants will pass away, and give place
to the finer herbage by which cattle or sheep are sup-
ported.

When the draining is finished, the lands which can
D d 4 not

Preparation not become objects of irrigation may be fertilized by
of Land. lime, or by means of the practice of paring and burn-
ing.

To improve a moor by lime, let it be opened in winter. A strong dose of caustic lime ought as soon as possible to be laid upon the surface of the land in a state of fine powder, that it may attach itself to every part. The lime will consume the roots of heath and of coarse grasses, and in a few months render the soil extremely friable. Lime has the effect of utterly destroying heath, and of converting it into a valuable manure. Economy in the use of this ingredient, therefore, is extremely misapplied. Accordingly, some skilful farmers lay one dose of lime upon the land before it is ploughed, and another after it, that the furrow-slices and the whole tops and roots of the heath and other plants being wholly surrounded by this caustic ingredient, may be sooner reduced into a state of friable mould.

In spring, after the frost is over, a slight harrowing will fill up all the interstices in the furrows with mould to keep out the air and rot the turf or sod. Thus the land may be suffered to lie during the following summer and winter, which will tend more to rot this kind of moorish turf than if it had been laid open to the air by ploughing. Next April let it be cross-ploughed, braked, and harrowed, till it be sufficiently pulverized for turnip-seed; at the same time, as much manure as can possibly be obtained ought to be given to it, and the manure mixed with the soil.

Swampy lands, and a soil covered with rushes, ant-hills, and coarse grasses, may be treated advantageously in a manner somewhat different. Where lime is to be found in abundance, it is proper to pare the surface,
and

and to collect the whole turf into heaps in different parts of the field, and make it up into compost with lime. The whole heaps in such cases ought to be thoroughly moistened, and the mass to be well turned and mixed. In this way all the roots and coarse herbage will be destroyed, and gradually reduced into a most valuable manure, for enriching the soil over which it ought to be spread, and thereafter ploughed in.

The second mode of improving waste lands of every kind is by paring and burning the surface. When land is pared, a thin sod is taken off, either by a paring spade, or paring plough, over the whole surface. The sods being dried, are collected into small heaps and burnt, and the ashes are scattered over the field. This practice has been found so obviously useful in the first instance, at least, that it has been extended by many farmers to all soils upon breaking them up from grass, though formerly cultivated and in good order, especially where lime cannot easily be obtained. At the same time, as the propriety of the practice is still greatly disputed, it may be proper to adopt this opportunity of taking some general notice of the subject. By one set of writers, says the Rev. Mr Arthur Young *, the practice is pronounced to be contrary to every principle; that it is a wasteful extravagant operation which dissipates what should be retained, annihilates oils and mucilage, calcines salts, and reduces fertile organic matter into ashes of very weak efficacy; that the vegetable particles which are brought into play at once for the production of a single crop, by less desperate management, might

* *Communications to the Board of Agriculture*, vol. ii.

Preparation might be husbanded to the support of many. On the of Land. contrary, the advocates for this operation assert that these objections are all founded on vain reasoning and speculative theory; that practice the most decided, and experience the most extended, pronounce it to be an admirable system; and that the mischiefs often quoted as flowing from it are to be attributed merely to the abuse of the method, and are by no means necessarily connected with it.

"I must without the least hesitation declare, says this writer, that the latter of these opinions is that to which I subscribe. To trust to reasoning in matters of agriculture is a most dangerous reliance: I shall leave others to detail their philosophical speculations, and rest what I have to offer solely on the practice, various and extensive, of numerous agriculturists, and on the common husbandry of many spacious districts.

"These agree in declaring (and it is most particularly to be had in remembrance, for the enemies of the practice admit it), that by paring and burning you may command two or three good corn crops in succession. The fact cannot be denied; for whether you examine the peat of the Cambridgeshire fens, or the fallow chalk soils of the downs and wolds of Hampshire, Gloucestershire, or the east riding of Yorkshire, it is known that bad farmers do act thus absurdly; they get indeed great crops, but they too often take them in succession, to the injury of the soil, though not to its ruin, unless that can be esteemed the ruin of land, which enables the tenant to pay double rent for it. Such farmers have been in the habit of burning for wheat, and then taking two crops of spring-corn, all good. Now it might be asked, how is it possible that that husbandry can produce

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all the evils detailed above, which enables a soil naturally poor and weak to give two or three good crops of corn? Their argument evidently proves too much; the effect shows that there is a powerful cause or agent in burning which they do not understand, which escapes from the retort of the chemist, and from the *rationale* of the theorist. That operation or manure which will give a good crop of wheat will give a good crop of turnip or cabbage; and he who, having made this commencement for the food of sheep on the land, and knows not how to go on, preserving the advantage he has gained, is a novice in the art of husbandry. The farmers that are railed at know it as well as their philosophical instructors; but avarice, united with the baneful effect of short or no leases, makes them practise against their judgments.

“ Paring and burning will on all sorts of land give turnip or cabbage; these fed on the land by sheep, will secure barley or oats, and seeds; the seeds, fed with sheep, whether for a short or a longer duration, will secure another crop of corn adapted to the soil; and in this stage of the progress, the soil will have gained much more than it has lost. To instance cases which I have seen, and quote authorities for these assertions, would be tiresome. I can assure the Board, that instances might be produced from more than half the counties of the kingdom.

“ It has often been contended, that burning lessens the soil. If this happen any where, it must be in peat: yet in the fens of Cambridgeshire this husbandry has been repeated once in eight years for a century and a half; and the proofs of a loss of depth are extremely vague in every instance I have met with, and hardly to

Preparation be distinguished from that undoubted subsidence which *of Land.* takes place in drained bogs of every description. In all other soils the assertion may be safely and positively denied: I have calcined pared turf, not calcareous, after careful separation and weighing, and in a heat far exceeding what is ever given in burning in the field, and, reweighing, found the loss too minute to attribute to any thing but loss of water intimately combined, but driven off by heat; and re-exposing the earth to the atmosphere free from rain, found an increase rather than a diminution of weight. The vegetable particles only are reduced to ashes; these, in any method of patrefaction, would dissolve; and combining with water, be exhaled by heat or absorbed by the vessels of plants. In ashes these are in a more fixed state relatively to the influences of the atmosphere; and that plants feed on them, the great crops which succeed offer abundant proof.

“ In addition to these circumstances is the capital one of destroying insects, grubs, and weeds: these are apt to abound most in the richer soils; no reason for abstaining from this husbandry on such.

“ I venture, therefore, to conclude, that paring and burning with a proper course of crops, is safe on any soil, and essentially necessary on some, as I shall presently shew.

“ *Clay.*—The gentlemen who have objected to paring and burning, have not given many reasons peculiarly appropriate to this soil; the only one that merits the least attention is, the assertion, that it converts what is properly soil into pieces of unfertile brick: the fact is not so; for every one who has burnt clay for manure knows, that though there be many lumps of the sub-

stance which they allude to, yet that the mass of the Preparation of Land.
heap consists of ashes, properly so called ; but when the tenacity of this soil is considered (which is one of its greatest evils), it will be found, that bricks are an excellent addition to the soil, to loosen and open its stubborn adhesion.

“ Heaps of clay-ashes, amounting to many hundreds of loads, have been burnt, and applied to great profit on this soil. By paring and burning, therefore, you have on it the common manure found in vegetable ashes ; and you have in addition a substance which acts mechanically. Hitt, who wrote from practice, and abounds with many just observations, remarks, ‘ I recommend burning of the surface as the cheapest manure, and most effectual of any ; for it not only adds salts to the soil (which the burning of grafts roots produces) but it opens part of the stratum of clay next the soil so much that the roots of vegetables can afterwards feed therein ; for when the turf of a piece of land has been burnt in heaps at four or five yards apart, though all the ashes be taken away with some of the earth, and spread over the other parts of the land ; yet neither corn nor turnips will grow so vigorously there, as on those places that were only opened by heat.’ ”

Even upon good loams, on which the practice is most condemned, this writer supports it upon the authority of his own experience, as well as upon the experience of some respectable farmers. With regard to sandy soils, he alleges that he has seen them also improved by it in Suffolk and in Cambridgeshire. With regard to chalk, he observes, that it is the common method of breaking up downs in every part of England. On the Cottiswold hills in Gloucestershire, it is the common

Preparation mon husbandry, and often repeated. In Hampshire
of Land. and Warwickshire the same husbandry prevails, and the sheep walks and warrens on the wolds of the east riding of Yorkshire and of Lincolnshire have thus been brought most profitably into culture. With regard to peat, he states, that "whatever variety of sentiments there may be for this method on other soils, here there can be none. The universal practice from the flat fens of Cambridgeshire to the swelling bogs of Ireland, on the mountainous moors on the north of England, and on the rough sedgy bottoms in almost every part of the kingdom, when fresh lands are broken up by men of real practice and observation, is to begin by paring and burning."

The following remarks upon the subject, in the Report of the Agriculture of the county of Northumberland, by J. Bayley and G. Culley, are worthy of attention. "Paring and burning is not much practised in the eastern and northern parts of the county: in the middle and southern parts it is most prevalent; but, even there, it is confined to old swards, and coarse, rough, rushy, and heathy lands. For the first breaking up of such ground, it is certainly very convenient, and preferable to any other mode we have ever seen; but though we are fully convinced of its beneficial effects in such situations, yet we have our doubts whether it could be used with advantage upon lands that have lain a few years in grass, and that would produce good crops of grain immediately on being ploughed out, which is not the case with coarse rough heathy lands, or even very old swards on rich fertile soils; it being found that crops on the latter are frequently very much injured by leaping for two or three years, which paring and burning entirely obviate, and ensure full crops to the farmer,

mer, who need not be under any apprehension of his Preparation of Land.
soil being ruined by it, provided he pursue the following course: 1. Turnips; 2. Oats; 3. Fallow well limed for turnips; 4. Barley sown up with clover and grass seeds, and depastured with sheep for three or four years. It is the injudicious cropping, more than the ill effects derived from paring and burning, that has been the chief cause of bringing such an odium on this practice, which is certainly an excellent one in some situations, and when properly conducted; but, like the fermented juice of the grape, may be too often repeated and improperly applied.

"The popular clamour against this practice, "that it destroys the soil," we can by no means admit; and are inclined to believe, that not a single atom of soil is abstracted, though the bulk of the sod or turf be diminished. This arises from the burning of the roots or vegetable substances, which, by this process, afford a considerable portion of alkaline salts, phlogistic or carbonic matter, and probably other principles friendly to vegetation; as we find those ashes produce abundant crops of turnips, which fatten stock much quicker than those after any other dressing or manure we have ever seen; and the succeeding crops of corn are so very luxuriant as to tempt the injudicious cultivator to pursue it too far; who, for the sake of a temporary gain, may be said to rip it up, as the boy did his goose that laid golden eggs."

In the Annals of Agriculture various instances are exhibited of the successful use of this practice, as well as of the abuse of it. In one paper upon the subject *
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Preparation the editor himself remarks, when speaking of a district of Land. of Hampshire which he surveyed, that “the argument commonly heard is, that it lessens the staple of a thin soil: but facts are clear against this; for if it were true, there are soils that would have been much more than lessened, for they would have been all gone centuries ago. The practice is known to have been of great antiquity, and not to be executed but in proportion as a *turf* is formed; the president de la Tour d’Aigues showed me lands in Provence that had been pared and burnt probably for 2000 years, and he justly ridiculed the idea of wasting the soil. The question is, whether you shall rot or burn the vegetable particles? and that method is apparently the best which produces the best crops. Every man with his eyes open, in this country, will see the crops given by paring; the practice is the basis of all the good crops I have seen, and they have many that would do credit to much richer countries.”

John Dalton, Esq. an experienced agriculturist, in a communication addressed to the Board of Agriculture*, expresses himself thus: “The best method I ever found of converting grass-land into tillage is unquestionably by paring and burning: you get into a good course of husbandry at once, turnips, barley, &c. &c. and it is a mere chimera to suppose that the soil is diminished by it. I have myself pared and burned the same field twice in the course of 15 years, and could never discover that the soil was in the smallest degree diminished by the operation.”

Upon

* *Communic.* vol. iii.

Upon the whole, whatever judgment may be pronounced with regard to the practice of paring and burning, when applied to lands which have been previously cultivated, there appears to be no doubt, that it is the best of all modes of breaking up a fresh, rude, and hitherto untouched soil. The only hazard in the performance of it is, that the men accustomed to the work rarely cut deep enough on peaty soils to destroy the ling root and branch. It is better, when practicable, to plough and burn the furrow; and, when not practicable, to add something to the common price for having the work done to a greater depth. The effect of this operation is prodigious on these soils; it destroys the spontaneous growth quicker and more effectually than any other method: a whole year's tillage and fallowing are inferior in this respect. It furnishes a manure which is very well adapted to the nature of the ground; for it has been found on abundance of trials, that no manure exceeds the ashes of chimnies in mountainous countries wherein the surface of those mountains is the fuel of the people; a fact that holds true in proportion to the depth to which they are dug; the ashes of the pure *heavy* black bog being the best of all. But the singular advantage of this mode of breaking up is the suddenness with which a black moor becomes green under a flourishing crop of cabbage, rape, or turnip. It may be burnt in a north-east drying wind, in the spring, and in July covered with useful vegetation.

It is believed, that the practice of paring and burning was originally introduced in situations in which lime or proper fuel for burning limestone could not readily be obtained. It is observed, however, by a judicious writer

Preparation ter in the Annals of Agriculture*, that “experience has proved that the addition of lime to the ashes of the pared surface operates more beneficially than if spread in any other manner. The larger the quantity, the greater the effect, and probably the greater the *proportional* effect ; that is, six chaldrons an acre will do more than twice the good of three chaldrons ; the chemical effect both in neutralizing the acids found in all these soils, and also in destroying the roots left of the spontaneous growth depending in some measure on the effect taking place suddenly. It has been known, that eight chaldrons an acre laid on at once, have converted a moor to meadow worth 25s. an acre ; but the same moor under one chaldron per acre per annum for eight years, has not been worth 7s. 6d. an acre. The effect of lime on all soils long in cultivation is problematical, and does not answer the expence in one case in ten ; but in new moor lands, the effect is prodigious and hardly credible. Laid on ling mountains without tillage, without paring, or other operation than merely cutting the ling, and spreading the lime, such moors have been changed from 1s. to 20s. per acre ; but the quantity has been 15 and 20 chaldrons per acre. The best guide in laying on lime is the expence ; a prudent man would be cautious of going further than 40s. an acre, and at the extreme 3l. ; even at 40s. the total expence of the improvement will run high.”

After paring and burning when the ashes are spread, which is supposed to be in the month of May, the field should be ploughed true, but shallow, in order not to bury

bury the ashes too deep ; then harrowed very well till Preparation
fine, and ploughed shallow again cross. This, with a second good harrowing, will mix and incorporate the
soil and ashes so well, that it is scarcely possible to miss
a crop of turnips if any rain at all fall during the month
of June.

The most important point in all attempts to improve Course of
waste lands, consists of adopting a proper course of improving
crops after the land is broke up. This is indeed the waste lands,
keystone of the arch ; and if this object be not attend-
ed to with singular care, and correct views adopted con-
cerning it, the whole improvement will infallibly fail
in profit, and perhaps prove a ruinous speculation. It
ought to be observed then, that although the use of
lime, or of paring and burning with or without the ad-
dition of lime, may do much towards the temporary
production of crops upon a new soil, yet that such sti-
mulating manures must not be relied on as sources of
permanent fertility. The great object, therefore, with
every improver of lands, ought to be to consider well
in what manner he may most readily obtain the com-
mand of large quantities of dung, for the purpose of
putting the soil truly and substantially into good heart
or condition. If this is not done, he has only ex-
changed bad grafts for bad crops, and has obtained no
real advantage by the change. That course of crops,
therefore, ought to be adopted, which affords the most
abundant subsistence for a great number of cattle or of
sheep. With this view, turnips are the readiest re-
source, because they succeed well upon a new soil,
with little or no dung. The turnip crop, therefore,
which ought always to be the first after breaking up,
may be wholly consumed upon the soil by sheep or

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calves :

Preparation of Land. calves : the land will thus be enriched by their dung with little trouble or expence. The benefit arising from this mode of proceeding is so great, that it ought not to terminate with a single year, but ought to be followed by another crop of turnips during the second year, to be consumed upon the land in like manner ; and some improvers have even advantageously proceeded the length of taking a third crop of turnips, though probably it might prove more advantageous, as the land is new dunged, to take a crop of cabbages during the third year, always remembering, that the whole dung produced by the cattle fed upon this crop, ought to be restored to the new soil. After these green crops, the land will be in excellent condition for laying down with grass seeds. The most correct mode of sowing grass seeds, in such a case, no doubt, is to put upon the ground no other crop at the same time with themselves ; but, as barley succeeds extremely well after turnips, and is, at the same time, in other respects, the kind of grain that is most advantageously used along with grass seeds, a crop of barley thinly sown may be taken at the same time.

If the land that has thus been brought under the plough forms part of a cold, bleak, and mountainous region, the best plan that can be adopted for rendering it profitable, is that which brings it most speedily and perfectly into condition to become a valuable pasture for sheep. When this, therefore, is the object in view, which in all such situations it ought to be, rye-grass need not be used as one of the grass seeds ; and, at all events, a crop of hay ought not to be taken, as this would tend to exhaust the soil, and to retard the speedy formation of a close and rich pasture. If the lands, however, are in

in such a situation, that they may be expected to be Preparation
used with advantage for the frequent production of ~~of Land.~~
crops of grain, a crop of hay may be taken as increasing
the quantity of food for cattle, and thereby giving an
additional command of manure ; and the land may, af-
ter another year or two, be restored to tillage.

5. *Forming Ridges.*

The first thing that occurs on this head, is to consider what grounds ought to be formed into ridges, and what ought to be tilled with a flat surface. Dry soils, which suffer by lack of moisture, ought to be tilled flat, which tends to retain moisture. And the method for such tilling, is to go round and round from the circumference to the centre, or from the centre to the circumference. This method is advantageous in point of expedition, as the whole is finished without once turning the plough. At the same time, every inch of the soil is moved, instead of leaving either the crown or the furrow unmoved, as is commonly done in tilling ridges. Clay soil, which suffers by water standing on it, ought to be laid as dry as possible by proper ridges. A loamy soil is the middle between the two mentioned. It ought to be tilled flat in a dry country, especially if it incline to the soil first mentioned. In a moist country, it ought to be formed into ridges, high or low according to the degree of moisture and tendency to clay.

In grounds that require ridging, an error prevails, Evils attending too
that ridges cannot be raised too high. High ridges la- high ridges,
hour under several disadvantages. The soil is heaped upon the crown, leaving the furrows bare : the crown is too dry, and the furrows too wet : the crop, which

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Preparation is always best on the crown, is more readily shaken of Land. with the wind, than where the whole crop is of an equal height ; the half of the ridge is often covered from the sun, a disadvantage which is far from being slight in a cold climate. High ridges labour under another disadvantage, in ground that has no more level than barely sufficient to carry off water : they sink the furrows below the level of the ground ; and consequently retain water at the end of every ridge. The furrows ought never to be sunk below the level of the ground. Water will more effectually be carried off by lessening the ridges both in height and breadth : a narrow ridge, the crown of which is but 18 inches higher than the furrow, has a greater slope than a very broad ridge, where the difference is three or four feet.

Ridges on declivities. Next, of forming ridges where the ground hangs considerably. Ridges may be too steep as well as too horizontal : and if to the ridges be given all the steepness of a field, a heavy shower may do irreparable mischief. To prevent such mischief, the ridges ought to be so directed cross the field, as to have a gentle slope for carrying off water slowly, and no more. In that respect, a hanging field has greatly the advantage of one that is nearly horizontal ; because, in the latter, there is no opportunity of a choice in forming the ridges. A hill is of all the best adapted for directing the ridges properly. If the soil be gravelly, it may be ploughed round and round, beginning at the bottom and ascending gradually to the top in a spiral line. This method of ploughing a hill requires little more force than ploughing on a level ; and at the same time removes the great inconvenience of a gravelly hill, that rains go off too quickly ; for the rain is retained in every

every furrow. If the soil be such as to require Preparation of Land, ridges, they may be directed to any slope that is proper.

In order to form a field into ridges that has not been formerly cultivated, the rules mentioned are easily put in execution. But what if ridges be already formed, that are either crooked or too high? After seeing the advantage of forming a field into ridges, people were naturally led into an error, that the higher the better. But what could tempt them to make their ridges crooked? Certainly this method did not originate from design; but from the laziness of the driver suffering the cattle to turn too hastily, instead of making them finish the ridge without turning. There is more than one disadvantage in this slovenly practice. First, the water is kept in by the curve at the end of every ridge, and sours the ground. Next, as a plough has the least friction possible in a straight line, the friction must be increased in a curve, the back part of the mouldboard pressing hard on the one hand, and the coulter pressing hard on the other. In the third place, the plough moving in a straight line, has the greatest command in laying the earth over. But where the straight line of the plough is applied to the curvature of a ridge in order to heighten it by gathering, the earth moved by the plough is continually falling back, in spite of the efforts of the most skilful ploughman.

The inconveniences of ridges high and crooked are so many, that one would be tempted to apply a remedy at any risk. And yet, if the soil be clay, it would not be advisable for a tenant to apply the remedy upon a lease shorter than two nineteen years. In a dry gravelly soil, the work is not difficult nor hazardous.

Preparation of Land. When the ridges are cleaved two or three years successively in the course of cropping, the operation ought to be concluded in one summer. The earth, by reiterated ploughings, should be accumulated upon the furrows, so as to raise them higher than the crowns : they cannot be raised too high, for the accumulated earth will subside by its own weight. Cross ploughing once or twice, will reduce the ground to a flat surface, and give opportunity to form ridges at will. The same method brings down ridges in clay soil ; only let care be taken to carry on the work with expedition ; because a hearty shower, before the new ridges are formed, would soak the ground in water, and make the farmer suspend his work for the remainder of that year at least. In a strong clay, we would not venture to alter the ridges, unless it can be done to perfection in one season. On this subject Dr Anderson has the following observations *.

Inconveniences in the common methods of levelling.

" The difficulty of performing this operation properly with the common implements of husbandry, and the obvious benefit that accrues to the farmer from having his fields level, has produced many new inventions of ploughs, harrows, drags, &c. calculated for speedily reducing the fields to that state ; none of which have as yet been found fully to answer the purpose for which they were intended, as they all indiscriminately carry the earth that was on the high places into those that were lower ; which, although it may in some cases render the surface of the ground tolerably smooth and level, is usually attended with inconveniences,

far

* *Essays on Agriculture*, vol. I. p. 146.

far greater, for a considerable length of time, than that Preparation
which it was intended to remove. of Land.

“ For experience sufficiently shows, that even the best vegetable mould, if buried for any length of time so far beneath the surface as to be deprived of the benign influences of the atmosphere, loses its *vis viva*, if I may be allowed that expression; becomes an inert lifeless mass, little fitted for nourishing vegetables; and constitutes a soil very improper for the purposes of the farmer. It therefore behoves him, as much as in him lies, to preserve, on every part of his fields, an equal covering of that vegetable mould that has long been uppermost, and rendered fertile by the meliorating influence of the atmosphere: But, if he suddenly levels his high ridges by any of these mechanical contrivances, he of necessity buries all the good mould that was on the top of the ridges in the old furrows; by which he greatly impoverishes one part of his field, while he too much enriches another; insomuch that it is a matter of great difficulty, for many years thereafter, to get the field brought to an equal degree of fertility in different places; which makes it impossible for the farmer to get an equal crop over the whole of his field by any management whatever: and he has the mortification frequently, by this means, to see the one half of his crop rotted by an over-luxuriance, while other parts of it are weak and sickly, or one part ripe and ready for reaping, while the other is not properly filled; so that it were, on many occasions, better for him to have his whole field reduced at once to the same degree of poorness as the poorest of it, than have it in this state. An almost impracticable degree of attention in spreading the manures may indeed in some measure get the better

Preparation better of this : but it is so difficult to perform this pro-
of Land.
perly, that I have frequently seen fields that had been
thus levelled, in which, after thirty years of continued
culture and repeated dressings, the marks of the old
ridges could be distinctly traced when the corn was
growing, although the surface was so level that no
traces of them could be perceived when the corn was
off the ground.

" But this is a degree of perfection in levelling that
cannot be usually attained by following this mode of
practice ; and, therefore, is but seldom seen. For all
that can be expected to be done by any levelling ma-
chine, is to render the surface perfectly smooth and
even in every part, at the time that the operation is
performed : but as, in this case, the old hollows are
suddenly filled up with loose mould to a great depth,
while the earth below the surface upon the heights of
the old ridges remains firm and compact, the new raised
earth after a short time subsides very much, while the
other parts of the field do not sink at all ; so that in
a short time the old furrows come to be again below
the level of the other parts of the field, and the water
of course is suffered in some degree to stagnate upon
them ; insomuch that, in a few years, it becomes ne-
cessary once more to repeat the same levelling process,
and thus renew the damage that the farmer sustains by
this pernicious operation.

Levelling sometimes
not to be attempted. " On these accounts, if the farmer has not a long
lease, it will be found in general to be much his inter-
est to leave the ridges as he found them, rather than
to attempt to alter their direction ; and, if he attends
with due caution to moderate the height of these old
ridges, he may reap very good crops, although perhaps

at a somewhat greater expence of labour, than he Preparation
would have been put to upon the same field, if it had of Land.
been reduced to a proper level surface, and divided into
straight and parallel ridges.

“ But, where a man is secure of possessing his ground for any considerable length of time, the advantages that he will reap from having level and well laid out fields, are so considerable as to be worth purchasing, if it should be even at a considerable expence. But the loss that is sustained at the beginning, by this mechanical mode of levelling ridges, if they are of considerable height, is so very great, that it is perhaps doubtful if any future advantages can ever fully compensate it. I would therefore advise, that all this levelling apparatus should be laid aside; and the following more efficacious practice be substituted in its stead: A practice that I have long followed with success, and can safely recommend as the very best that has yet come to my knowledge.

“ If the ridges have been raised to a very great height, as a preparation for the ensuing operations, ^{Best method of} ~~levelling~~, they may be first *cloven*, or *scalded* out, as it is called in different places; that is, ploughed so as to lay the earth on each ridge from the middle towards the furrows. But if they are only of a moderate degree of height, this operation may be omitted. When you mean to proceed to level the ground, let a number of men be collected, with spades, more or fewer as the nature of the ground requires, and then set a plough to draw a furrow directly across the ridges of the whole field intended to be levelled. Divide this line into as many parts as you have labourers, allotting to each one ridge or two, or more or less, according to their number,

Preparation number, height, and other circumstances. Let each of Land the labourers have orders, as soon as the plough has passed that part assigned him, to begin to dig in the bottom of the furrow that the plough has just made, about the middle of the side of the old ridge, keeping his face towards the old furrow, working backwards till he comes to the height of the ridge; and then turn towards the other side of the ridge, always throwing the earth that he digs up into the deep old furrow between the ridges, that is directly before him; taking care not to dig deep where he first begins, but to go deeper and deeper as he advances to the height of the ridge, so as to leave the bottom of the trench he thus makes across the ridge entirely level, or as nearly so as possible. And when he has finished that part of the furrow allotted to him that the plough has made in going, let him then go and finish in the same manner his own portion of the furrow that the plough makes in returning. In this manner, each man performs his own task through the whole field, gradually raising the old furrows as the old heights are depressed. And, if an attentive overseer is at hand, to see that the whole is equally well done, and that each furrow is raised to a greater height than the middle of the old ridges, so as to allow for the subsiding of that loose earth, the operation will be entirely finished at once, and never again need to be repeated.

“ In performing this operation, it will always be proper to make the ridges, formed for the purpose of levelling, which go across the old ridges, as broad as possible; because the deep trench that is thus made in each of the furrows is an impediment in the future operations,

, as well as the height that is accumulated in the <sup>Preparation
of Land.</sup> middle of each of these ridges ; so that the fewer there are of these, the better it is. The farmer, therefore, will do well to advert to this in time, and begin by forming a ridge by always turning the plough to the right hand, till it becomes of such a breadth as makes it very inconvenient to turn longer in that manner ; and then, at the distance of twice the breadth of this new-formed ridge from the middle of it, mark off a furrow for the middle of another ridge, turning round it to the right hand, in the same manner as was done in the former, till it becomes of the same breadth with it ; and then, turning to the left hand, plough out the interval that was left between the two new-formed ridges. By this mode of ploughing, each ridge may be made of 40, 50, or 60 yards in breadth, without any great inconvenience ; for although some time will be lost in turning at the ends of these broad ridges, yet as this operation is only to be once performed in this manner, the advantage that is reaped by having few open furrows, is more than sufficient to counterbalance it. And, in order to moderate the height that would be formed in the middle of each of these great ridges, it will always be proper to mark out the ridges, and draw the furrow that is to be the middle of each, some days before you collect your labourers to level the field ; that you may, without any hurry or loss of labour, clear out a good trench through the middle of each of the old ridges ; as the plough, at this time, going and returning nearly in the same track, prevents the labourers from working properly without this precaution.

“ If these rules are attended to, your field will be at once reduced to a proper level, and the rich earth that formed

Preparation formed the surface of the old ridges be still kept upon
of Land. the surface of your field ; so that the only loss that the
possessor of such ground can sustain by this operation,
is merely the expence of performing it."

Dr Anderson afterwards makes a calculation of the different expences of levelling by the plough and by the spade, in which he finds the latter by far the cheapest method.

Proper direction of the ridges. Let it be a rule to direct the ridges north and south, if the ground will permit. In this direction, the east and west sides of the ridges, dividing the sun equally between them, will ripen at the same time.

Narrow ridges an advantage. It is a great advantage in agriculture, to form ridges so narrow, and so low, as to admit the crowns and furrows to be changed alternately every crop. The soil nearest the surface is the best ; and by such ploughing, it is always kept near the surface, and never buried. In high ridges, the soil is accumulated at the crown and the furrows left bare. Such alteration of crown and furrow is easy where the ridges are no more but seven or eight feet broad. This mode of ploughing answers perfectly well in sandy and gravelly soils, and even in loam ; but it is not safe in clay soil. In that soil, the ridges ought to be 12 feet wide, and 20 inches high ; to be preserved always in the same form by casting, that is, by ploughing two ridges together, beginning at the furrow that separates them, and ploughing round and round till the two ridges be finished. By this method, the separating furrow is raised a little higher than the furrows that bound the two ridges. But at the next ploughing, that inequality is corrected, by beginning at the bounding furrows, and going

round and round till the ploughing of the two ridges be Preparation
completed at the separating furrow. of Land.

6. Of Cleaning Ground.

For this purpose a new instrument, termed a *cleaning harrow*.
harrow.
Plate IV.
strongly recommended *. It is one entire piece like the fig. 5.
first of those mentioned above, consisting of seven bulls,
four feet long each, two and one-fourth inches broad,
two and three-fourths deep. The bulls are united to-
gether by sheths, similar to what were mentioned above.
The intervals between the bulls being three and three-
fourths inches, the breadth of the whole harrow is
three feet five inches. In each bull are inserted eight
teeth, each nine inches free below the wood, and di-
stant from each other six inches. The weight of each
tooth is a pound, or near it. The whole is firmly bound
by an iron plate from corner to corner in the line of the
draught. The rest as in the harrows mentioned above.
The size, however, is not invariable. The cleaning
harrow ought to be larger or less according as the soil
is stiff or free.

To give this instrument its full effect, stones of such
a size as not to pass freely between the teeth ought to
be carried off, and clods of that size ought to be bro-
ken. The ground ought to be dry, which it commonly
is in the month of May.

In preparing for barley, turnip, or other summer-
crop, begin with ploughing and cross ploughing. If
the

* In his *Gentleman Farmer*; to which performance the practical part
of this treatise is materially indebted.

Preparation of Land. the ground be not sufficiently pulverized, let the great
brake be applied, to be followed successively with the
Plate IV. 1st and 2d harrows. In stiff soil, rolling may be pro-
per, once or twice between the acts. These operations
will loosen every root, and bring some of them to the
surface. This is the time for the 3d harrow, conducted
by a boy mounted on one of the horses, who trots
smartly along the field, and brings all the roots to the
surface: there they are to lie for a day or two, till
perfectly dry. If any stones or clods remain, they
must be carried off in a cart. And now succeeds the
operation of the cleaning harrow. It is drawn by a
single horse, directed by reins, which the man at the
opposite corner puts over his head, in order to have
both hands free. In this corner is fixed a rope, with
which the man from time to time raises the harrow
from the ground, to let the weeds drop. For the sake
of expedition, the weeds ought to be dropt in a straight
line cross the field, whether the harrow be full or
not; and seldom is a field so dirty, but that the har-
row may go 30 yards before the teeth are filled. The
weeds will be thus laid in parallel rows, like those of
hay raked together for drying. A harrow may be
drawn swiftly along the rows, in order to shake out
all the dust; and then the weeds may be carried clean
off the field in carts. But we are not yet done with
these weeds; instead of burning, which is the ordinary
practice, they may be converted into useful manure,
by laying them in a heap with a mixture of hot dung
to begin fermentation. At first view, this way of
cleaning land will appear operose; but, upon trial,
neither the labour nor expence will be found immod-
erate. At any rate, the labour and expence ought
not

not to be grudged; for if a field be once thoroughly Preparation
cleaned, the seasons must be very cross, or the farmer of Land.
very indolent, to make it necessary to renew the operation in less than 20 years. In the worst seasons, a few years pasture is always under command; which effectually destroys triennial plants, such as thistles and couch-grass.

7. On the Nature of different Kinds of Soils, and the Plants proper to each.

1. Clay, which is in general the stiffest of all soils, Clay soil. and contains an unctuous quality. But under the term *clays*, earths of different sorts and colours are included. One kind is so obstinate, that scarcely anything will subdue it; another is so hungry and poor, that it absorbs whatever is applied, and turns it into its own quality. Some clays are fatter than others, and the fattest are the best; some are more soft and slippery. But all of them retain water poured on their surface, where it stagnates, and chills the plants, without sinking into the soil. The closeness of clay prevents the roots and fibres of plants from spreading in search of nourishment. The blue, the red, and the white clay, if strong, are unfavourable to vegetation. The stony and looser sorts are less so; but none of them are worth any thing till their texture is so loosened by a mixture of other substances, and opened, as to admit the influence of the sun, the air, and frosts. Among the manures recommended for clay, sand is of all others to be preferred; and sea sand is the best of all, where it can be obtained. This most effectually breaks the cohesion.

The reason for preferring sea sand is, that it is not
VOL. I. F f formed

Preparation of Land. formed wholly (as most other sands are) of small stones; but contains a great deal of calcareous matter in it, such as shells grated and broken to pieces by the tide, and also of salts. The smaller the sand is, the more easily it penetrates the clay; but it abides less time in it than the larger.

The next best sand is that washed down by rains on gravelly soils. Those which are dry and light are the worst. Small gritty gravel has also been recommended by the best writers on agriculture for these soils; and in many instances we have found it to answer the purpose.

Shell marl, ashes, and all animal and vegetable substances, are very good manures for clay; but they have been found most beneficial when sand is mixed with them. Lime has been often used; but the writer of this section would not recommend it, for he never found any advantage from it singly, when applied to clays.

The crops most suitable for such lands are, wheat, beans, cabbages, and rye-grass. Clover seldom succeeds, nor indeed any plants whose roots require depth and a wide spread in the earth.

Chalky soil. 2. Chalk. Chalky soils are generally dry and warm, and if there be a tolerable depth of mould, fruitful; producing great crops of barley, rye, pease, vetches, clover, trefoil, burnet, and particularly sainfoin. The latter plant flourishes in a chalky soil better than any other. But if the surface of mould be very thin, this soil requires good manuring with clay, marl, loam, or dung. As these lands are dry, they may be sown earlier than others.

When your barley is three inches high, throw in ~~in~~ 10lb ~~in~~ b.

10lb. of clover, or **15lb.** of trefoil, and roll it well. The Preparation of Land. next summer mow the crop for hay; feed off the aftermath with sheep; and in winter give it a top-dressing of dung. This will produce a crop the second spring, which should be cut for hay. As soon as this crop is carried off, plough up the land, and, in the beginning of September, sow three bushels of rye per acre, either to feed off with sheep in the spring or to stand for harvest. If you feed it off, sow winter vetches in August or September, and make them into hay the following summer. Then get the land into as fine tilth as possible, and sow it with fainfoin; which, with a little manure, once in two or three years, will remain and produce good crops for 20 years together.

3. Light poor land, which seldom produces good crops of any thing till well manured. After it is well ploughed, sow three bushels of buck-wheat, per acre, in April or May: When in bloom, let your cattle in a few days to eat off the best, and tread the other down; this done, plough in what remains immediately. This will soon ferment and rot in the ground; then lay it fine, and sow three bushels of rye per acre. If this can be got off early enough, sow turnips; if not, winter vetches to cut for hay. Then get it into good tilth, and sow turnip-rooted cabbages, in rows three feet apart. This plant seldom fails, if it has sufficient room, and the intervals be well horse-hoed; and you will find it the best spring feed for sheep when turnips are over.

The horse-hoeing will clean and prepare the land for sainfoin; for the sowing of which April is reckoned the best season. The usual way is to sow it broad-cast, four bushels to an acre; but the writer

Preparation prefers sowing it in drills two feet asunder; for then
of Land. it may be horse-hoed, and half the seed will be sufficient:

The horse-hoeing will not only clean the crop, but earth up the plants, and render them more luxuriant and lasting.

If you sow it broad-cast, give it a top-dressing in December or January, of rotten dung or ashes, or, which is still better, of both mixed up in compost.

From various trials, it is found that taking only one crop in a year, and feeding the after-growth, is better than to mow it twice. Cut it as soon as it is in full bloom, if the weather will permit. The hay will be the sweeter, and the strength of the plants less impaired, than if it stand till the seed is formed.

Light rich land.

4. Light rich land, being the most easy to cultivate to advantage, and capable of bearing most kinds of grain, pulse, and herbage, little need be said upon it. One thing, however, is very proper to be observed, that such lands are the best adapted to the drill husbandry, especially where machines are used, which require shallow furrows to be made for the reception of the seed. This, if not prone to couch-grafs, is the best of all soils for lucerne; which, if sown in two feet drills, and kept clean, will yield an astonishing quantity of the most excellent herbage. But lucerne will never be cultivated to advantage where couch-grafs and weeds are very plentiful; nor in the broad-cast method, even where they are not so; because horse-hoeing is essential to the vigorous growth of this plant.

Coarse rough land.

5. Coarse rough land. Plough deep in autumn; when it has lain two weeks, cross-pleugh it, and let it lie rough through the winter. In March give it another good

good ploughing; drag, rake, and harrow it well, to <sup>Preparation
of Land.</sup> get out the rubbish, and sow four bushels of black oats per acre, if the soil be wet, and white oats if dry. When about four inches high, roll them well after a shower: This will break the clods; and the fine mould falling among the roots of the plants will promote their growth greatly.

Some sow clover and rye-grass among the oats, but this appears to be bad husbandry. If you design it for clover, sow it single, and let a coat of dung be laid on in December. The snow and rain will then dilute its salts and oil, and carry them down among the roots of the plants. This is far better than mixing the crops on such land, for the oats will exhaust the soil so much, that the clover will be impoverished. The following summer you will have a good crop of clover; which cut once, and feed the after-growth. In the winter plough it in, and let it lie till February: Then plough and harrow it well; and in March, if the soil be moist, plant beans in drills of three feet, to admit the horse-hoe freely. When you horse-hoe them a second time, sow a row of turnips in each interval, and they will succeed very well. But if the land be strong enough for sowing wheat as soon as the beans are off, the turnips may be omitted.

SECT. I.

CULTURE OF PARTICULAR PLANTS.

THE articles hitherto insisted on, are all of them preparatory to the capital object of a farm, that of raising plants for the nourishment of man and of other animals. These plants are of two kinds; culmiferous and leguminous; differing widely from each other. Wheat, rye, barley, oats, rye-grafs, are of the first kind: of the other kind are, pease, beans, clover, cabbage, and many others.

Culmiferous plants. Culmiferous plants, says Bonnet, have three sets of roots. The first issue from the seed, and push to the surface an upright stem; another set issue from a knot in that stem; and a third from another knot, nearer the surface. Hence the advantage of laying seed so deep in the ground as to afford space for all the sets.

Leguminous plants. Leguminous plants form their roots differently. Pease, beans, cabbage, have store of small roots, all issuing from the seed, like the undermost set of culmiferous roots; and they have no other roots. A potato and a turnip have bulbous roots. Red clover has a strong tap-root. The difference between culmiferous and leguminous plants, with respect to the effects they produce in the soil, will be noticed afterwards, in the section concerning rotation of crops. As the present section is confined to the propagation of plants, it falls naturally to be divided into three articles: first, Plants cultivated

cultivated for fruit ; second, Plants cultivated for roots ; third, Plants cultivated for leaves.

Culture of
particular
Plants

I. *Plants Cultivated for Fruit.*

I. WHEAT and RYE.

Anciently when the summer fallow was almost the only means employed for restoring the exhausted fertility of the soil, this practice was universally adopted throughout Europe as a preparation for wheat. In France, excepting the Netherlands, the practice still continues ; and in our own country it is still used to a considerable extent. The great loss, however, both of time and labour, which is occasioned by a summer fallow, has induced intelligent husbandmen to make great exertions for the purpose of avoiding the necessity of it, as a preparation for this valuable but exhausting crop. For this purpose, extraordinary tillage and extraordinary manure have been substituted for summer fallow. As it is found that wheat does not succeed so well, if sown on land immediately after dunging, as it does when a previous crop is taken after the dung ; an inducement has thereby been held out, to substitute to fallows those green crops for which the drill husbandry is best adapted. In the neighbourhood of Edinburgh, accordingly, a crop of potatoes is frequently made use of instead of a fallow ; but, as potatoes greatly exhaust the soil, this practice is only adopted in consequence of the great command of manure which the neighbourhood of the city gives to the farmers. In other situations a less exhausting crop must be used. Turnips, though otherwise suitable, are, in the general case, excluded, because they cannot be advantageously consumed

Culture of sowed till it is too late in the season to sow wheat.
particular

Plants It has frequently been asserted, that of all the drilled crops, beans are most valuable as a preparation for wheat. An important experiment upon this subject was made by the duke of Grafton, of which an account is given in a letter from his grace to Mr Young, dated in August, 1799 *. " Being arrived at the eighth year of that experiment, which I undertook at your desire, it appears to me that this may be a proper time to communicate to you the result of the trial.

" You will recollect, that the object was to find out, Whether that sort of land usually met with in the common fields of Northamptonshire and the adjacent counties, would or would not bear alternately a crop of wheat, and then of beans, and *vice versa* of beans, and then of wheat; after giving it, as in the open fields, a light dressing of muck, viz. from twelve to fifteen loads per acre every third year, without rendering the land poorer than when it was first undertaken. In order to ascertain this point as accurately as possible, I pitched upon a field of moderate land, rather of a stiffish nature; better than the worst, and much inferior to the best, in our open fields. The method I then pursued was the following: After having manured it in the manner specified above, I sowed the first year a moiety of the field with wheat, and the other part with beans; and every season since I have been changing the crops, making them alternate from beans to wheat, and from wheat to beans each year, never having admitted a fallow.



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* *Annals of Agriculture*, vol. xxviii.

“ It would give me more satisfaction if I could have furnished you with the measured particulars of each year’s produce from both crops, but unluckily I have mislaid the paper. I can only, therefore, relate from memory, that the difference between these crops, and those of the same grain on other parts of the farm, was not such, on an average of those years, as would be worth regarding. The third and sixth years, being the farthest from the mucking, were, of course, the worst produce, though not remarkably so; and I will venture to pronounce, that the crops have kept up, on an average, with the seasons, and have been but little inferior to the produce of the other fields on my farm. My farmer assures me, from accounts he has kept, that the best end of the land, has, on the average, yielded four quarters of wheat per acre, and the poorer end three quarters and a half. He is further of opinion, that the land, in point of heart, is neither improved nor worse, for any agricultural purpose, than it was when first we began. According to my judgment, the course of husbandry has rather been favourable to the field; for the thorough hand-hoeing of the bean crop every other spring has rendered it so clean, that in the present wet year, there is scarcely any weed grown through the wheat crop, although it was laid flat five weeks ago.

“ I have stated these facts as plainly and as clearly as I could in order to be understood, and I leave to others to draw their deductions.

“ This experiment by no means goes to prove that there may be no spots where a summer fallow may not come into an eligible course; but I think I may say, that it is not necessary for land of a quality like mine.

Culture of mine. To bring it into practice in the open common particular fields, I well know, that many circumstances are to be considered; and among these, I shall be asked where the farmer is, in such a case, to keep his sheep, as in farms of that nature he has so little pasture, and would be distressed were he to lose the manure from the folding of these sheep. This becomes a new question, and deserves consideration. Much, I conceive, may be said upon it; and, if I mistake not, some means may be found to obviate the objection.

"I omitted mentioning one circumstance, which may merit the attention of a farmer; it is this: Whether, after the given coat of muck every third year, the wheat crop, which preceded that of beans, had a claim to a preference to that which was sown after the beans; and here I do not hesitate to give my opinion in favour of the latter. I apprehend, that the hoeing of the beans cleared the lands of such weeds as might have been brought on with the muck, and still left the ground in good heart for the wheat.

"I wish to add, that a neighbouring farmer has, on seeing the effect of this culture of mine, carried it into practice with a little alteration; for he has mucked his field every second year in the winter, and sowed it in spring, with the bean crop preceding that of wheat. Nor has he, any more than myself, had to complain that the bean crop, directly on the mucking, ran so much into height as to weaken the stem, and prevent its being properly kidded. Indeed this is the general notion of farmers in this part of the country; taken up, I believe, entirely from a groundless tradition, and not at all from proof.—P. S. The wheat was cut yesterday, and the reapers tell me that it is fair in hand, lighter than

than last year's, but heavier than that of the season before."

Culture of
particular
Plants.

Upon this interesting subject of preparing land for wheat, the most important discovery undoubtedly is, the use of red clover for that purpose, upon a soil that is tolerably open. It binds the soil, and gives to it a degree of tenacity which is extremely suitable to wheat; at the same time, that the roots of the plant rotting in the earth afford a valuable manure: and in whatever way clover may act as a preparation for this grain experience leaves no doubt of its beneficial effects. The wheat ought to be sown upon the first year's clover after a single ploughing. To do it every justice, the clover ought to be only once mown. The after crop ought to be fed upon the land, which ought not to be overstocked with cattle, that a considerable quantity of the green crop may be ploughed in. In the use of clover, however, some caution is necessary. Mr Young remarks *, that "all good farmers in England know, from long experience, that the common red clover is no friend to clean farming, if sown with a second or third crop of corn. In the course, 1st, Turnips or cabbages; 2d, Barley or oats; 3d, Clover; 4th, Wheat; the land is kept in garden order. But, if after that fourth crop the farmer goes on and sows, 5th, Barley or oats; 6th, Clover; 7th, Wheat; the land will be both foul and exhausted. In a word, clover is beneficial to the really good and clean farmer, only to the extent of his turnips, cabbages, and fallow; and never ought to be sown but on land previously cleaned by those hoeing crops

* *Travels*, vol. ii.

Culture of crops or fallow. As to fallow, no Frenchman ever makes it but for wheat ; consequently the culture of clover is excluded. I have often seen it sown in this course : 1st, Fallow ; 2d, Wheat ; 3d, Barley ; 4th, Oats ; 5th, Clover ; 6th, Clover ; 7th, Wheat ; 8th, Oats ; and the land inevitably full of weeds. I may venture to assert, that clover thus introduced or even in courses less reprehensible, but not correct, will do more mischief than good, and that a country is better cultivated without than with it. Hence, let the men, emulous of the character of good farmers, consider it as essential to good husbandry to have no more clover than they have turnips and cabbages, or some other crop that answers the same end, and never to sow it but with the first crop of corn : By these means their land will be clean, and they will reap the benefits of the culture without the common evils.

"I have read in some authors an account of great German farmers, having such immense quantities of clover as are sufficient to prove the utter impossibility any preparation : these quantities are made a matter of boast. We know, however, in England, in what manner to appreciate such extents of clover."

As a great part of our island consists of a clayey soil, which is the least of all suited to green or drilled crops, many skilful farmers are still of opinion, that upon such soils the use of summer fallow cannot with propriety be relinquished ; and, as others, from a love of old practices, are unwilling in any case to relinquish it, we shall here give a general account of the mode of practising it.

Fallowing for wheat. Any time from the middle of April to the middle of May, the fallowing may commence. The moment should

should be chosen, when the ground, beginning to dry, has yet some remaining softness: in that condition, the soil divides easily by the plough, and falls into small parts. This is an essential article, deserving the strictest attention of the farmer. Ground ploughed too wet, rises, as we say, *whole-fur*, as when pasture-ground is ploughed: where ploughed too dry, it rises in great lumps, which are not reduced by subsequent ploughings; not to mention, that it requires double force to plough ground too dry, and that the plough is often broken to pieces. When the ground is in proper order, the farmer can have no excuse for delaying a single minute. This first course of fallow must, it is true, yield to the barley-feed; but as the barley-feed is commonly over the first week of May, or sooner, the season must be unfavourable if the fallow cannot be reached by the middle of May.

As clay soil requires high ridges, these ought to be cleaved at the first ploughing, beginning at the furrow, and ending at the crown. This ploughing ought to be as deep as the soil will admit: and water-furrowing ought instantly to follow; for if rain happen before water-furrowing, it stagnates in the furrow, necessarily delays the second ploughing till that part of the ridge be dry, and prevents the furrow from being mellowed and roasted by the sun. If this first ploughing be well executed, annual weeds will rise in plenty.

About the first week of June, the great brake will loosen and reduce the soil, encourage a second crop of annuals, and raise to the surface the roots of weeds moved by the plough. Give the weeds time to spring, which may be in two or three weeks. Then proceed to the second ploughing about the beginning of July; which

^{Culture of} which must be cross the ridges, in order to reach all particular ^{Plants.} the slips of the former ploughing. By cross-ploughing the furrows will be filled up, and water-furrowing be still more necessary than before. Employ the brake again about the 10th of August, to destroy the annuals that have sprung since the last stirring. The destruction of weeds is a capital article in fallowing: yet so blind are people to their interest, that nothing is more common than a fallow field covered with charlock and wild mustard, all in flower, and 10 or 12 inches high. The field having now received two harrowings and two brakings is prepared for manure, whether lime or dung, which without delay ought to be incorporated with the soil by a repeated harrowing and a gathering furrow. This ought to be about the beginning of September, and as soon after as you please the seed may be sown.

As in ploughing a clay soil it is of importance to prevent poaching, the hinting furrows ought to be done with two horses in a line. If four ploughs be employed in the same field, to one of them may be allotted the care of finishing the hinting furrows.

Dressing loam for wheat. Loam, being a medium between sand and clay, is of all soils the fittest for culture, and the least subject to chances. It does not hold water like clay; and when wet, it dries sooner. At the same time, it is more retentive than sand of that degree of moisture which promotes vegetation. On the other hand, it is more subject to couch-grass than clay, and to other weeds; to destroy which, fallowing is still more necessary than in clay.

Beginning the fallow of this kind of soil about the first of May, or as soon as barley feed is over, take as

deep a furrow as the soil will admit. Where the ridges are so low and narrow as that the crown and furrow can be changed alternately, there is little or no occasion for water-furrowing. Where the ridges are so high as to make it proper to cleave them, water-furrowing is proper. The second ploughing may be at the distance of five weeks. Two crops of annuals may be got in the interim, the first by the brake and the next by the harrow; and by the same means eight crops may be got in the season. The ground must be cleared of couch-grass and knot-grass roots, by the cleaning harrow described above. The time for this operation is immediately before the manure is laid on. The ground at that time being in its loosest state, parts with its grass roots more freely than at any other time. After the manure is spread, and incorporated with the soil by braking or harrowing, the seed may be sown under furrow, if the ground hangs so as easily to carry off the moisture. To leave it rough without harrowing has two advantages: it is not apt to cake with moisture, and the inequalities make a sort of shelter to the young plants against frost. But if it lie flat, it ought to be smoothed with a slight harrow after the seed is sown, which will facilitate the course of the rain from the crown to the furrow.

A sandy soil is too loose for wheat. The only chance Dressing a for a crop is after red clover, the roots of which bind sandy soil. Rye is a crop much fitter for sand soil than wheat; and like wheat, it is generally sown after a summer fallow.

Lastly, Sow wheat as soon in the month of October Time for as the ground is ready. When sown a month more sowing. early, it is too forward in the spring, and apt to be hurt

by

Culture of ^{particular} by frost : when sown a month later, it has not time to take root before frost comes on ; and frost casts it out of the ground.

^{Setting of wheat,} *Setting of wheat*, may be here noticed as being a method which by some is reckoned one of the greatest improvements in husbandry that took place during the late century. It seems to have been first suggested by planting grains in a garden from mere curiosity, by persons who had no thought or opportunity of extending it to a lucrative purpose. Nor was it attempted on a larger scale, till a little farmer near Norwich began it upon less than an acre of land. For two or three years only a few followed his example ; and these were generally the butt of their neighbours merriment for adopting so singular a practice. They had, however, considerably better corn and larger crops than their neighbours : this, together with the saving in seed, engaged more to follow them : while some ingenious persons, observing its great advantage, recommended and published its utility in the Norwich papers. These recommendations had their effect. The curiosity and inquiry of the Norfolk farmers (particularly round Norwich) were excited, and they found sufficient reason to make general experiments. Among the rest was one of the largest occupiers of land in that county, who set 57 acres in one year. His success, from the visible superiority of his crop, both in quantity and quality, was so great, that the following autumn he set 300 acres, and has continued the practice ever since. This noble experiment established the practice, and was the means of introducing it generally among the intelligent farmers in a very large district of land ; there being few who now sow any wheat, if they can procure hands

^{a capital improvement in agriculture.}

to set it. It has been generally observed, that although the set crops appear very thin during the autumn and winter, the plants side-shoot and spread prodigiously in the spring. The ears are indisputably larger, without any dwarfish or small corn; the grain is of a larger bulk, and specifically heavier per bushel than when sown.

The lands on which this method is particularly prosperous, are either after a clover stubble, or on which trefoil and grass seeds were sown the spring before the last. These grounds, after the usual manuring, are once turned over by the plough in an extended flag or turf, at ten inches wide; along which a man, who is called a *dibbler*, with two setting-irons, somewhat bigger than ramrods, but considerably bigger at the lower end, and pointed at the extremity, steps backwards along the turf, and makes the holes about four inches asunder every way, and an inch deep. Into these holes the droppers (women, boys, and girls) drop two grains, which is quite sufficient. After this, a gate bushed with thorns is drawn by one horse over the land, and closes up the holes. By this mode, three pecks of grain are sufficient for an acre; and being immediately buried, the grain is equally removed from vermin or the power of frost. The regularity of its rising gives the best opportunity of keeping it clear from weeds, by weeding or hand-hoeing.

Wheat-setting is a method peculiarly beneficial when corn is dear; and, if the season be favourable, may be practised with great benefit to the farmer. Sir Thomas Beevor of Hethel-Hall in Norfolk, found the produce to be two bushels per acre more than from the wheat which is sown; but having much less small corn

VOL. I. G g intermixed

Culture of intermixed with it, the sample is better, and always ^{pa. 162} ~~Plants.~~ fetches a higher price, to the amount generally of two shillings per quarter.

This method, too, saves to the farmer and to the public six pecks of seed wheat in every acre; which, if nationally adopted, would of itself afford bread for more than half a million of people.

Add to these considerations, the great support given to the poor by this *second* harvest, as it may be called, which enables them to discharge their rents and maintain their families without having recourse to the parish.—The expence of setting by hand is now reduced to about six shillings per acre; which, in good weather, may be done by one dibbler, attended by three droppers, in two days. This is five shillings per day; of which if the dibbler gives to the children sixpence each, he will have himself three shillings and sixpence for his day's work, which is much more than he can possibly earn by any other labour so easy to himself. But put the case, that the man has a wife who dibbles with him, and two or three of his own children to drop to him, you see his gains will then be prodigious, and enough to ensure a plenty of candidates for that work, even in the least populous parts of the country.

It is, however, to be observed with regard to this method, that in seasons when seed-corn is very cheap, or the autumn particularly unfavourable to the practice, it must certainly be lessened. In light lands, for instance, a very dry feed time prevents dibbling; as the holes made with the instruments will be filled up again by the mould as fast as the instrument is withdrawn. So, again, in a very wet season, on strong and stiff clays, the seeds in the holes cannot be well and properly cov-

vered by the bushes drawn over them. But these extremes of dry and wet do not often happen, nor do they affect lands of a moderately consistent texture, or both light and heavy soils at the same time; so that the general practice is in fact never greatly impeded by them.

Culture of particular Plants.

Propagating of wheat by dividing and transplanting its roots. In the Philosophical Transactions for 1768, we meet with a very important experiment, of which the following is an abstract. On the 2d of June 1766, Mr C. Miller sowed some grains of the common red wheat; and on the 8th of August a single plant was taken up and separated into 18 parts, and each part planted separately. These plants having pushed out several side-hoots, by about the middle of September; some of them were then taken up and divided, and the rest of them between that time and the middle of October. This second division produced 67 plants. These plants remained through the winter, and another division of them, made between the middle of March and the 12th of April, produced 500 plants. They were then divided no further, but permitted to remain. The plants were in general stronger than any of the wheat in the fields. Some of them produced upwards of 100 ears from a single root. Many of the ears measured seven inches in length, and contained between 60 and 70 grains.

Propagating of wheat by dividing the roots.

The whole number of ears which, by the process above mentioned, were produced from one grain of wheat, was 21,109, which yielded three pecks and three quarters of clean corn, the weight of which was 47lb. 7 ounces; and from a calculation made by counting the

Culture of number of grains in an ounce, the whole number of particular Plants. grains was about 576,840.

By this account we find, that there was only one general division of the plants made in the spring. Had a second been made, Mr Miller thinks the number of plants would have amounted to 2000 instead of 500, and the produce thereby been much enlarged.

The ground was a light blackish soil, upon a gravelly bottom; and, consequently, a bad foil for wheat. One half of the ground was well dunged, the other half had no manure. There was, however, not any difference discoverable in the vigour, or growth, or produce, of the plants.

It must be evident, that the expence and labour of setting in the above manner by the hand, will render it scarcely practicable upon a large scale so as to be productive of any utility. A correspondent of the Bath Society, therefore, (Robert Bogle, Esq. of Daldowin, near Glasgow, with a view to extend the practice, has proposed the use of the harrow and roller until some better implements be invented. This method occurred to him from attending to the practice usual with farmers on certain occasions, of harrowing their fields after the grain is sprung up. Upon investigating the principles upon which these practices are founded, he found them confined merely to that of pulverizing the earth, without any attention to Mr Miller's doctrine. They said, "that after very heavy rains, and then excessive dry weather, the surface of their lands was apt to be caked, the tender fibres of the young roots were thereby prevented from pushing, and of course the vegetation was greatly obstructed; in such instances,

they

they found very great benefit from harrowing and rolling. Culture of particular Plants.

These principles he acknowledges to be well founded, so far as relates to pulverizing ; but contends, that the benefit arising from harrowing and rolling is not derived from pulverizing entirely, but also from subdividing and enabling the plants to tiller (as it is termed), or side-shoot. " The harrow (he observes) certainly breaks the incrustation on the surface, and the roller crumbles the clods ; but it is also obvious, that the harrow removes a great many of the plants from their original stations ; and that if the corn has begun to tiller at the time it is used, the roots will be, in many instances, subdivided, and then the application of my system of divisibility comes into play. The roller then serves to plant the roots which have been torn up by the harrow."

But on this the Society observe, that the teeth of a harrow are too large to divide roots so small and tenacious as are those of grain ; and whenever such roots (however tilled) stand in the line any tooth makes, they will, if small, be only turned on one side by the earth yielding to their lateral pressure, or, if large, the whole root will probably be drawn out of the ground. The principal uses, therefore, derived from harrowing and rolling these crops are, opening the soil between the plants, earthing them up, breaking the clods, and closing the earth about their roots.

In a subsequent letter, Mr Bogle, without contesting these points, further urges the scheme of propagating wheat by dividing and transplanting its roots. " I have conversed (says he) much with many practical farmers, who all admit that my plan has the appearance not only of being practical, but advantageous. I have

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also seen, in the ninth number of Mr Young's *Annals of Agriculture*, the account of an experiment which strongly corroborates my theory. It was made by the Rev. Mr Pike of Edmonton. From this, and other experiments which have been made under my own eye, I foresee clearly, that the system is practicable, and will certainly be productive of great benefit, should it become general. Besides the saving of nine-tenths of seed in the land sown broad-cast, other very important advantages will attend the setting out of wheat from a seed-bed : such as an early crop ; the certainty of good crops ; rendering a summer-fallow unnecessary ; saving dung ; and having your wheat perfectly free from weeds without either hand or horse-hoeing. Five hundred plants in April produced almost a bushel of grain. My gardener says, he can set one thousand plants in a day, which is confirmed by the opinion of two other gardeners. Mr Miller found no difference in the produce of what was planted on lands that had dung, and on what had none, except where the land was improper for wheat at all."

Bath Socie-
ty's obser-
vations.

On this letter we have the following note by the Society : " Mr Bogle will see, by the Society's premium book this year, that by having offered several premiums for experiments of the kind he so earnestly recommends, we wish to have his theory brought to the test of practice. Our reason for this, as well as for printing Mr B's letter, was rather to excite decisive trials by ingenious persons, than from any expectation of the practice ever becoming a general one. General, indeed, it never can be. A sufficient number of hands could not be found to do it. Unkindly seasons at the time of transplanting and dividing the roots would frequently

quently endanger and injure, if not destroy, the crops. But admitting the mode generally practicable, we very much doubt whether all the advantages he has enumerated would be derived from this mode of culture. Why should dividing and transplanting the roots of wheat cause the crop to be early, or afford a *certainty* of its being a *good one*? We cannot think that *less manure* is necessary in this method than either in drilling or broad-cast; nor can we by any means admit, such crops would ‘be perfectly free from weeds without either hand or horse-hoeing.’ We readily agree with Mr Bogle, that by this mode of culture on a general scale, an immense quantity of seed-corn would be annually saved to the nation; and in this, we believe, the advantage, were it practicable, would principally consist.”

Upon the same subject, and that of harrowing all kinds of corn, we are informed, Mr Bogle afterwards communicated to the Society his thoughts more at large, together with authentic accounts which were made at his instance, and which were attended with very great success. These must undoubtedly be regarded as of very great importance, and accordingly the Society, conceiving his system may be attended with considerable advantages if brought into general practice, have given, at the end of their third volume, a few of his leading principles. Mr Bogle states,

1. That he has known many instances of very great crops having been obtained by harrowing fields of corn after they were sprouted; and therefore recommends the practice very warmly.

2. That he has also received an authentic account of

Culture of one instance where the same good effects were produced
particular Plants by ploughing the field.

3. On the system of transplanting, he states, that a very great proportion of the seed will be saved, as a farmer may have a nursery, or small patch of plants, from which his fields may be supplied; he calculates that one acre will yield plants sufficient for 100 acres.

4. That a very great increase of crops may be obtained by this method, probably a double crop, nay perhaps a triple quantity of what is reaped either by drilling or by the broad-cast husbandry.

5. That a great part of the labour may be performed by infirm men and women, and also by children, who are at present supported by the parish charity; and that of course the poor's rates may be considerably reduced.

6. That the expence will not exceed from 20s. to 30s. per acre, if the work be performed by able-bodied men and women; but that it will be much lower, if that proportion of the work which may be done by employing young boys and girls should be allotted to them.

7. That in general he has found the distance of nine inches every way a very proper distance for setting out the plants at; but recommends them to be tried at other spaces, such as 6, 8, or even 12 inches.

8. That he conceives an earlier crop may be obtained in this manner than can be obtained by any other mode of cultivation.

9. That a clean crop may also be procured in this way; because if the land be ploughed immediately before the plants are set out, the corn will spring much quicker from the plants than the weeds will do from their

their seeds; and the corn will thereby bear down the growth of the weeds.

Culture of particular Plants.

10. That such lands as are overflowed in the winter and spring, and are of course unfit for sowing with wheat in the autumn, may be rendered fit for crops of wheat by planting them in the spring, or even in the summer.

11. That he has known instances of wheat being transplanted in September, October, November, February, March, April, and even as late as the middle of May, which have all answered very well.

12. That he has known an early kind of wheat sown as late as the middle of May, which has ripened in very good time; and from that circumstance he conceives, if the plants should be taken from that early kind, the season of transplanting might be prolonged at least till the 1st of July, perhaps even later.

13. That he has reason to think wheat, oats, and barley, are not annuals, but are perennials, provided they are eaten down by cattle and sheep, or are kept low by the scythe or sickle; and are prevented from spindling or coming to the ear.

14. That one very prevalent motive with him in prosecuting this plan, is, that he is of opinion it may enable government to devise means of supporting the vagrant poor, both old and young, who are now to be met with everywhere, both in towns and in the country, and who are at present a burden on the community: but if such employment could be struck out for them, a comfortable subsistence might be provided for them by means of their own labour and industry; and not only save the public and private charitable contributions, but may also render that class of people useful and profitable

Culture of able subjects; instead of their remaining in a useless,
particular
Plants, wretched, and perhaps a profligate and vicious course
of life.

Lastly, Mr Bogle has hinted at a secondary object which he has in view, from this mode of cultivation, which he apprehends may in time, with a small degree of attention, prove extremely advantageous to agriculture.—It is, that, in the first place, the real and intrinsic value of different kinds of grain may be more accurately ascertained, by making a comparison of it with a few plants of each kind set out at the same time, than can be done when sown in drills or broad-cast; and when the most valuable kinds of wheat, oats, of barley, are discovered, he states, that in a very short time (not exceeding four or five years) a sufficient quantity of that valuable kind may be procured to supply the kingdom with seed from a single grain of each kind; for he calculates, that 47,000 grains of wheat may be produced by divisibility in two years and three months.

Observation of the Bath So-
ciety.

Upon these propositions the Society observes, "That although Mr Bogle appears to be too sanguine in his expectations of seeing his plan realized in *general practice*, it certainly merits the attention of gentlemen farmers. We wish them to make fair experiments, and report their success. All grand improvements have been, and ever will be, progressive. They must necessarily originate with gentlemen; and thence the circle is extended by almost imperceptible degrees over provinces and countries. At all events, Mr Bogle is justly entitled to the thanks of the Society, and of the public, for the great attention he has paid to the subject."

There is perhaps no part of Great Britain where
wheat

wheat is cultivated to more perfection than in Norfolk. Mr Marshal informs us, that the species raised in that county is called the *Norfolk red*, and weighs heavier than any other which has yet been introduced, though he owns that its appearance is much against the assertion, it being a long thin grain, resembling rye more than well-bodied wheat. About 15 or 20 years ago a new species was introduced, named the *Kentish cob*; against which the millers were at first very much prejudiced, though this prejudice is now got over. A remarkable circumstance respecting this grain is, that though upon its introduction into the county the *cob* or husk be perfectly white, yet such is the power either of the soil or of the mode of cultivation to produce what the botanists call *varieties*, that the grain in question is said to lose every year somewhat of the whiteness of its husks, until they become at last equally red with those of the former kind. The southern and south-eastern parts of the county generally enjoy a stronger and richer soil than the more north-easterly, and therefore are more proper for the cultivation of that species of grain. In the northern parts are some farms of very light soil, where the farmers sow only a small quantity of wheat; and these light lands are called *barley farms*.

The greatest part of the wheat in Norfolk is sown ^{succession} upon a second year's ley: sometimes it is sown upon ^{of crops,} &c. a first year's ley; sometimes on a summer fallow; after peas, turnips, or buck harvested or ploughed under. The practice adopted by those who are looked upon as superior husbandmen in the county of Norfolk is as follows: The second year's leys having finished the *bullocks*, and brought the stock cattle and horses through

Culture of through the fore part of summer, and the first year's particular plants. leys having been made ready to receive his stock, the farmer begins to break up his old land or ley ground Rice-balk-ing, by a peculiar mode of cultivation named *rice-balking*, a particular mode in which the furrow is always turned toward the un-ploughed ground, the edge of the coulter passing always close by the edge of the flag last turned. This is done at first with an even regular furrow; opportunity being taken for performing the operation after the surface has been moistened by a summer shower. In this state his summer leys remain until towards the end of harvest, when he harrows and afterwards ploughs them across the balks of the former ploughing, bringing them now up to the full depth of the soil. On this ploughing he immediately harrows the manure, and ploughs it in with a shallow furrow. The effects of this third ploughing are to mix and effectually pulverize the soil and manure; to cut off and pulverize the upper surfaces of the furrows of the second ploughing; and thus, in the most effectual manner, to eradicate or smother the weeds which had escaped the two former ones. Thus it lies until the seed time, when it is harrowed, rolled, sown, and gathered up into ridges of such width as the farmer thinks most proper. Those of six furrows are most common, though some very good farmers lay their wheat land into four-furrow, and others into ten-furrow ridges; "which last (says our author) they execute in a style much superior to what might be expected from wheel-ploughs." They excel, however, in the six-furrow ploughing; of which Mr Marshal gives a particular account. When ploughing in this manner, they carry very narrow furrows; so that a six-furrow ridge, set out by letting the off-horse return in

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the first-made furrow, does not measure more than three feet eight or nine inches. Culture of particular Plants.

When wheat is cultivated after the first year's ley, the seed is generally sown upon the flag or furrow turned over. After pease, one or two ploughings are given; the other parts of the management being the same with that after the second year's ley already mentioned. After buck harvested he seldom gives more than two, and sometimes but one, ploughing. In the former case he spreads his manure on the stubble, and ploughs it in with a shallow furrow; harrows, rolls, sows, and gathers up the soil into narrow work. The manure is in like manner spread on the stubble after once ploughing, and the seed is then sown among the manure; the whole ploughed in together, and the soil gathered up into narrow ridges, as if it had undergone the operations of a fallow. An inconvenience attending this practice is, that the buck which is necessarily shed in harvesting springs up among the wheat, and becomes a weed to it, at the same time that the rooks, if numerous, pull up both buck and wheat, leaving several patches quite bare. This is obviated in a great measure by first ploughing in the manure and self-sown buck with a shallow furrow, in consequence of which the buck vegetates before the wheat.

It is likewise a favourite practice with the Norfolk farmers to raise wheat after buck ploughed under. They plough under the buck by means of a broom made of rough bushes fixed to the fore tackle of the plough between the wheels, which bears down the plant without lifting the wheels from the ground. Sometimes, when the buck is strong, they first break it down with a roller going the same way that the plough is intended

Culture of ~~ed to go;~~ afterwards a good ploughman will cover it ~~particular~~ ^{Plants} so effectually that scarce a stalk can be seen. Sometimes the surface of the ground is left rough, but it is more eligible to harrow and roll it. The practice of summer-fallowing seldom occurs in Norfolk; though sometimes, when the soil has been much worn down by cropping, and overrun by weeds, it is esteemed a judicious practice by many excellent husbandmen, and the practice seems to be daily gaining ground. After turnips the soil is ploughed to a moderate depth, and the seed sown over the first ploughing: but if the turnips be got in early, the weeds are sometimes first ploughed in with a shallow furrow, and the seed ploughed under with a second ploughing, gathering the soil into narrow ridges.

~~Manuring the ground in Norfolk~~ With regard to the manuring of the ground for wheat in Norfolk, that which has been recently clayed or marled is supposed to need no other preparation any more than that which has received 15 or 20 loads of dung and mould for turnips; the first year's ley having been teathed in autumn, and the second fed off. Where the soil is good, and the wheat apt to run too much to straw, it is the practice of some judicious farmers to set their manure upon the young clover, thereby depriving the wheat in some degree of its rankness; but it is most common to spread it upon the broken ground; or, if the seed be sown upon the turned furrow, to spread it on the turf and plough it under; or to spread it on the ploughed surface, and harrow it in with the seed as a top-dressing. A smaller quantity of manure is generally made use of for wheat than for turnips. From eight to ten cart loads (as much as three horses can conveniently draw) are reckoned

reckoned sufficient for an acre ; three or four chaldrons of lime to one acre, or 40 bushels of foot to the same quantity of ground ; or about a ton of rape-cake to three acres.

In this county they never begin to sow wheat till after the 17th of October, and continue till the beginning of December, sometimes even till Christmas. They give as a reason for this late sowing, that the wheat treated in this manner is less apt to run to straw than when sown earlier. The seed is generally prepared with brine, and candied in the usual manner with lime. The following method of preparing it is said to be effectual in preventing the smut. "The salt is dissolved in a very small quantity of water, barely sufficient for the purpose. The lime is flaked with this solution, and the wheat candied with it in its hottest state, having been previously moistened with pure water." According to our author's observation, the crops of those farmers who use this preparation are in general more free from smut than those who make use of any other.

The practice of dibbling or setting of wheat has not as yet become general throughout Norfolk, the common broad-cast method being usually followed, except on the Suffolk side of the county. Some few make use of dibbling and fluting rollers ; but drilling is almost entirely unknown, notwithstanding the great aptitude of soil for the practice. Ploughing in the seed under furrow is the favourite mode of the Norfolk farmers, and is performed in the following manner : "The land having been harrowed down level, and the surface rendered smooth by the roller, the head ploughman (if at leisure) marks out the whole piece in narrow slips of about a statute

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Ploughing
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Culture of statute rood in width. This he does by hanging up the particular ^{Plants.} plough in such a manner, that no part of it except the heel touches the ground; and this makes a sure mark for the seedsmen, which he cannot by any means mistake. In case the ploughs are all employed, the seedsmen himself marks the ground, by drawing a piece of wood or other heavy body behind him. Mr Marshal prefers this to the Kentish method of setting up sticks in the form of a lane, as being less liable to produce mistakes.

Instruments for dibbling wheat described. In those places where wheat is dibbled, they make use of iron instruments for the purpose. The acting part is an egg-shaped knob, somewhat larger than a pigeon's egg; the smaller end is the point of the dibble, the larger having a rod of iron rising from it about half an inch square, and two feet and a half long; the head being received into a cross piece of wood resembling the crutch of a spade or shovel, which forms the handle. The dibbler uses two of these instruments, one in each hand; and, bending over them, walks backward upon the turned furrows, making two rows of holes in each of them. Those rows are usually made at the distance of four inches from each other; the holes being two and a half or three inches distant, viz. four in each length of the foot of the dibbler. The great art in making these lies in leaving them firm and smooth in the sides, so that the loose mould may not run in to fill them up before the seeds are deposited. This is done by a circular motion of the hand and wrist; making a semi-revolution every stroke; the circular motion beginning as the bit enters, and continuing until it is entirely disengaged from the mould. The operation is not perfect unless the dibbles come out clean and wear bright.

bright. It is somewhat difficult to make the holes at equal distances ; but more especially to keep the two straight and parallel to each other, some practice being required to guide the instruments in such a manner as to correspond exactly with each other ; but though couples have been invented to remedy this inconvenience to keep them at a proper distance, the other method is still found to be preferable. A middling workman will make four holes in a second. One dibbler is sufficient for three droppers ; whence a man and three children are called a *set*. The dibbler carries on three flags or turned furrows ; going on some yards upon one of the outside furrows, and returning upon the other, after which he takes the middle one ; and thus keeps his three dibblers constantly employed, and at the same time is in no danger of filling up the holes with his feet. The droppers put in two or three grains of wheat into each hole ; but much time and patience is necessary to teach them to perform the business properly and quickly. An expert dibbler will hole half an acre in a day ; though one third of an acre is usually reckoned a good day's work. The seed is covered by means of a bush harrow ; and from one bushel to six pecks is the usual quantity for an acre. Notwithstanding the advantages of saving seed, as well as some others which are generally reckoned undeniable, it is here asserted by some very judicious farmers, that dibbling of wheat on the whole is not really a profitable practice. It is particularly said to be productive of weeds unless dibbled very thick : which indeed may probably be the case, as the weeds are thus allowed a greater space to vegetate in. Mr Marshal himself is of opinion, that " the dibbling of wheat ap-

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particular
plants.

Objections
against the
practice of
dibbling.

Culture of pears to be peculiarly adapted to rich deep soils, on particular Plants. which three or four pecks dibbled early may spread sufficiently for a full crop ; whereas light, weak, shallow soils, which have lain two or three years, and have become grassy, require an additional quantity of seed, and consequently an addition of labour, otherwise the plants are not able to reach each other, and the grasses of course find their way up between them, by which means the crop is injured and the soil rendered foul."

Culture of wheat in the midland district. The same author has likewise given an account of the method of cultivating wheat practised in other English counties. In the midland district, including part of Staffordshire, Derbyshire, Warwick, and Leicestershire, we are informed that the species usually sown is that called *Red Lammas*, the ordinary red wheat of the kingdom : but of late a species named the *Efford dun*, similar to the *Kentish white cob* of Norfolk, and the *Hertfordshire brown* of Yorkshire, has been coming into vogue. Cone-wheat, formerly in use in this district, is now out of fashion. Spring wheat is cultivated with remarkable success, owing principally to the time of sowing ; viz. the close of April. Our author was informed by an excellent farmer in these parts, that by sowing early, as in the beginning of March, the grain was liable to be shrivelled, and the straw to be blighted ; while that which was sown towards the end of April, or even in the beginning of May, produced clean plump corn. At the time he visited this county, however, it seemed to be falling into disrepute ; though he looks upon it, in some situations, especially in a turnip country, to be eligible. In the ordinary succession in this part of the kingdom, wheat comes

comes after oats; and there is perhaps nine-tenths of the wheat in this district sown upon oat-stubble. Our author has also seen a few examples of wheat being sown upon turf of six or seven years leying; and several others on clover ley once ploughed, as well as some after turnips. The best crops, however, produced in this, or, as he thinks, in any other district, are after summer fallow. The time of sowing is the month of October, little being sown before Michaelmas; and in a favourable season, little after the close of the month. Much seed is sown here without preparation. When any is made use of, it is the common one of brine candied with lime. The produce is very great, the medium being full three quarters per acre, sometimes four or five; and one farmer, in the year 1784, had on 50 acres of land together, no less than 45 bushels per acre.

In the Vale of Gloucester, the *cone-wheat*, a variety of the *triticum turgidum*, is cultivated, as well as the *lammas* and spring wheats. It is not, however, the true cone wheat which is cultivated here, the ears being nearly cylindrical; but our author met with the true species in North Wiltshire. Beans in this country are the common predecessors of wheat, and sometimes pease; but here the farmers cultivate wheat upon every species of soil. The time of sowing is in November and December, and the seed is thought to be sown in sufficient time if it is done before Christmas. In this country it is thought that late sown crops always produce better than those which are sown early; but Mr Marshal accounts for this by the vast quantity of weeds the latter have to encounter, and which the late sown crops escape by reason of the weakness of vegetation at

Culture of that time of the year. The produce, however, through particular Plants. out the Vale of Gloucester, is but very indifferent.—

Remarkably small sheaves.

Setting of wheat is not practised, but hoeing universally.—In harvesting, Mr Marshal observes, that the grain is allowed to stand until it be unreasonably ripe, and that it is bound up into very small sheaves. The practice of making double bands is unknown in this district; so that the sheaves are no bigger than can be contained in the length of single straw. The inconveniences of this method are, that the crop requires more time to stook, load and unload, and stack: the advantages are, that the trouble of making bands is avoided; and that if rainy weather happens to intervene, the small sheaves dry much sooner than the large ones. Here the crop is cut very high, the stubble and weeds being mown off in swaths for litter soon after the crop is cut; and sometimes fold as high as 5s. per acre.—Mr Marshal is at a loss to account for the little quantity produced in this country: it being hardly possible to derive it from the nature of the soil, almost all of it being proper for the cultivation of the grain.

In the Cotswold hills. Among the Cotswold hills of Gloucester the lamas and cone wheats are sown; and a new variety of the latter was raised not long ago by picking out a single grain of seed from among a parcel. The body is very long and large, but not sightly.—The Cotswold hills are almost proverbial for early sowing of wheat. The general rule is to begin ploughing in July, and sowing the first wet weather in August; so that here the seed-time and harvest of wheat coincide. If, in consequence of this early sowing the blade becomes rank in autumn, it is supposed to be proper to eat it down by putting a large flock of sheep upon it at once. Eating it in spring

is considered as pernicious. It is usually weeded with spud-hooks; not hoed, as in the Vale. One instance, however, is mentioned by our author, in which a very thin crop full of seed-weeds hoed in autumn with common success, occurred in the practice of a superior manager in this district; as well as others in which wheat has been weeded in autumn with great advantage. He also here met with a well authenticated instance of the good effect of cutting mildewed wheat while very green. "A fine piece of wheat being lodged by heavy rains, and being soon after perceived to be infected with the mildew, was cut, though still in a perfectly green state; namely, about three weeks before the usual time of cutting. It lay spread abroad upon the stubble until it became dry enough to prevent its caking in the sheaf; when it was bound and set up in shocks. The result of this treatment was, that the grain, though small, was of a fine colour, and the heaviest wheat which grew upon the same farm that season; owing, no doubt, to the thinness of its skin. What appears much more remarkable, the straw was perfectly bright, not a speck upon it.—In this part of the country, the produce of wheat is superior to that in the Vale; but Mr Marshal is of opinion, that the soil is much more fit for barley than wheat.

In Yorkshire, though generally a grass land country, and where of consequence corn is only a secondary concern, yet several kinds of wheat are cultivated, particularly *Zealand, Downy, Kent, Common White, Hertfordshire Brown, Yellow Kent, Common Red*. All these are varieties of winter wheat; besides which they cultivate also the *spring or summer wheat*. Here our author makes several curious observations concerning the raising of varieties

Culture of *varieties* of plants. "It is probable, says he, that time has particular Plants. the same effect upon the varieties of wheat and other grains as it has on those of cultivated fruits, potatoes, and other vegetable productions. Thus to produce an early pea, the gardener marks the plants which open first into blossom among the most early kind he has in cultivation. Next year he sows the produce of those plants, and goes over the coming crop in the manner he had done the preceding year, marking the earlier of this early kind. In a similar manner new varieties of apples are raised, by choosing the broadest leaved plants among a bed of seedlings rising promiscuously from pippins. Husbandmen, it is probable, have heretofore been equally industrious in producing fresh varieties of corn; or whence the endless variety of winter wheats? If they be naturally of one species, as Linnæus has deemed them, they must have been produced by climate, soil, or industry; for although nature sports with individuals, the industry of man is requisite to raise, establish, and continue a permanent variety. The only instance in which I have had an opportunity of tracing the *variety* down to the *parent individual*, has occurred to me in this district. A man of acute observation, having, in a piece of wheat, perceived a plant of uncommon strength and luxuriance, diffusing its branches on every side, and setting its closely-surrounding neighbours at defiance; marked it; and at harvest removed it separately. The produce was 15 ears, yielding 604 grains of a strong-bodied liver-coloured wheat, different, in general appearance, from every other variety he had seen. The chaff was smooth, without awns, and of the colour of the grain; the straw stout and reedy. These 604 grains were planted singly, nine inches apart,

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der, filling about 40 square yards of ground, on a clover stubble, the remainder of the ground being sown with wheat in the ordinary way; by which means extraordinary trouble and destruction by birds were avoided. The produce was two gallons and a half, weighing $20\frac{1}{2}$ lb. of prime grain for seed, besides some pounds of seconds. One grain produced 35 ears, yielding 1235 grains; so that the second year's produce was sufficient to plant an acre of ground. What deters farmers from improvements of this nature is probably the mischievousness of birds: from which at harvest it is scarcely possible to preserve a small patch of corn, especially in a garden or other ground situated near a habitation; but by carrying on the improvement in a field of corn of the same nature, that inconvenience is got rid of. In this situation, however, the botanist will be apprehensive of danger from the floral farina of the surrounding crop. But from what observations I have made, I am of opinion his fears will be groundless. No evil of this kind occurred, though the cultivation of the above variety was carried on among *white* wheat. But this need not be brought as an evidence: it is not uncommon here to sow a mixture of red and white wheats together; and this, it is confidently asserted, without impairing even the colour of either of them. The same mode of culture is applicable to the improvement of varieties, which perhaps would be more profitable to the husbandman than raising new ones, and more expeditious."

In Yorkshire the very singular preparation of seed ^{Preparation of wheat} wheat prevails which we formerly mentioned, viz. the ^{with arsenic.} steeping it in a solution of *arsenic*, as a preventive of ^{nic.} smut. Marshal was informed by one farmer, that he

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Culture of particular Plants.

Culture of had made use of this preparation for 20 years with suc-
cess, having never during that long space of time suf-
Plants. fered any sensible injury from it. Our author seems
inclined to believe the efficacy of this preparation; but
thinks there may be some reason to apprehend danger
in the use of such a pernicious mineral, either through
the carelessness of servants, or handling of the seed by
the person who sows it. The farmer above mentioned,
however, during all the time he used it, never experi-
enced any inconvenience either to himself, the feed-
man, or even to the poultry; though these last, we
should have thought, would have been peculiarly liable
to accidents from arsenicated seed. The preparation is
made by pounding the arsenic extremely fine, boiling
it in water, and drenching the seed with the decoction.
“ In strictness, says Mr Marshal, the arsenic should be
levigated sufficiently fine, to be taken up and washed
over with water, reducing the sediment until it be fine
enough to be carried over in the same manner. The
usual method of preparing the liquor is to boil one
ounce of white arsenic, finely powdered, in a gallon
of water, from one to two hours; and to add to the
decoction as much water or stale urine as will increase
the liquor to two gallons. In this liquor the seed is,
or ought to be, immersed, stirring it about in such a
manner as to saturate effectually the downy end of each
grain. This done, and the liquor drawn off, the seed
is considered as fit for the feed basket, without being
candied with lime, or any other preparation. A
bushel of wheat has been observed to take up about a
gallon of liquor. The price of arsenic is about 6d.
per pound; which, on this calculation, will cure four
quarters of seed. If no more than three quarters
be

be prepared with it, the cost will be only a farthing per bushel; but to this must be added the labour of pounding and boiling. Nevertheless, it is by much the cheapest, and perhaps, upon the whole, adds Mr Marshal, the best preparation we are at present acquainted with. In this county it is believed, that a mixture of wheat and rye, formerly a very common crop in these parts, is never affected with mildew; but our author does not vouch for the truth of this assertion.

Culture of particular Plants.

We must not here omit to take notice of a new mode ^{Wheat and} of cultivating wheat contrived by Mr. E. Walker of ^{turnips} Harply, Norfolk; which mode of culture we shall also ^{sown together.} afterwards have occasion to notice when we come to treat of the culture of turnips. Mr Walker thus explains his mode of procedure in a letter addressed to the publisher of the Annals of Agriculture *. "I sow in broad-cast, after the turnips have been once hoed, two bushels of wheat or two bushels of rye per acre; and then hoe the same in with the second hoeing: if it be hoed by the day it may be best, as it will be better done by the short strokes or cuts with the hoes than otherwise. It is recommended to be done soon after the first hoeing, for many reasons: It becomes a fine herbage, and keeps the land very clean, without any injury to the turnips, or to the wheat or rye. I began to feed in last September, the turnips, &c. the first of the month, and shall continue till all are done. I have fed off with all sorts of stock mixed, and have drawn out the turnips in lines to set the hurdles, as is usual, and fed off the turnips

* Vol. ix.

Cultivation of turnips and growing corn in wet and dry weather; but ~~particular~~ ^{particular} find that dry weather, and sheep, is the properst time and stock; and that sheep and light beasts are the best for light lands, which, on the whole, this method will greatly improve.

"All my experiments have been made without manuring, or any manure; for the turnip and wheat crop; and on those parts where I have fed off at the time it has been dry weather, though with all sorts of flock mixed and drawing as above, I have grown at the rate of five coomb of wheat per acre, and at the rate of eight coomb of rye per acre; and some was almost totally destroyed by feeding off in wet weather, as I was determined not to deficit, that I might know the bad or good effects from feeding off the turnips with the corn in different weather, as well as the different months; all which I shall be able to give information of next year, to those who wish to know. I find the feed nearly worth the cost of the seed corn, which is a material consideration in case you plough the land for barley or other summer corn; but if the wheat or rye stands a crop to your mind, it will do better to harrow it in the spring, at which time you may sow your grass seeds, which I find answer very well; or plough the stubble early in the autumn, and sow with clover or other seeds."

The well-known author of the *Annals of Agriculture* has given a farther account of this method of cultivation. The idea which led to Mr Walker's experiments was this: Wheat requires a certain degree of stiffness and compactness in the soil upon which it is reared. Of this compactness, sandy soils are apt to be deficient in proportion to the degree of tillage they receive.

ceive. Hence it occurred to Mr Walker, that if Culture of particular Plants. wheat could be sown without any ploughing at all, there would be a better chance of a crop upon certain soils, than after the most expensive system of tillage. Accordingly, in 1784, he executed his scheme on six acres of turnips, which were fed during the succeeding winter by bullocks and sheep, like the rest of his turnip fields, without making the least distinction on account of the wheat that had been sown and was growing among them. It is known, that turnip land, when fed off, is left highly manured and much trodden; and the question was, whether the first of these circumstances would not counterbalance the last? and, whether even the treading itself might not prove advantageous? The success justified the project, and, in 1785, Mr Walker extended it to 35 acres, a part of which was sown with rye. The management was the same as before; the wheat did better than the rye, and the best crop was where the turnips were eaten in the driest weather. In 1786, the same culture was extended to 70, and in 1797, to 100 acres, with complete success; but the crop was not better than that raised in the common way, though in general as good. The effect of this mode of culture, or the profit arising from it, consisted chiefly in this, that upon a farm of 600 acres, the labour of five horses was saved, and at the time of the barley-sowing, when all his neighbours were in the greatest hurry, he was at his ease quietly stirring his turnip fallows. The chief difficulty attending this mode of cultivating wheat arose from the wetness of the season at the time of feeding, as the ground was apt to be too much trodden and poached, particularly when the crop of turnips was very large so as to keep the cattle long

Culture of long upon them. On the contrary, in dry or frosty particular weather nothing of this kind happened. The greater the crop of turnips, and the more treading that occurred, the crop of wheat seemed afterwards to prosper the better. In a wet season, however, the evil arising from the treading was diminished when sheep alone without bullocks were introduced to confine the turnips. Under this husbandry, the following rotation was used: Two years grass put in among the wheat-stubble, ploughed once, and harrowed both in autumn and spring with the whole dung of the farm; Third year, oats; Fourth turnips; Fifth, wheat.

2. OATS.

Effect of frost upon tilled land. As winter-ploughing enters into the culture of oats, we must remind the reader of the effect of frost upon tilled land. Providence has neglected no region intended for the habitation of man. If in warm climates the soil be meliorated by the sun, it is no less meliorated by frost in cold climates. Frost acts upon water, by expanding it into a larger space. Frost has no effect upon dry earth; witness sand, upon which it makes no impression. But upon wet earth it acts most vigorously; it expands the moisture, which requiring more space puts every particle of the earth out of its place, and separates them from each other. In that view, frost may be considered as a plough superior to any that is made, or can be made, by the hand of man: its action reaches the minutest particles; and, by dividing and separating them, it renders the soil loose and friable. This operation is the most remarkable in tilled land, which gives free access to frost. With respect to clay soil in particular, there is no rule in husbandry

handy more essential than to open it before winter in hopes of frost. It is even advisable in a clay soil to leave the stubble rank ; which, when ploughed in before winter, keeps the clay loose, and admits the frost into every cranny.

To apply this doctrine, it is dangerous to plough clay soil when wet ; because water is a cement for clay, and binds it so as to render it unfit for vegetation. It is, however, less dangerous to plough wet clay before winter than after. A succeeding frost corrects the bad effects of such ploughing ; a succeeding drought increases them.

The common method is, to sow oats on new-ploughed land in the month of March, as soon as the ground is tolerably dry. If it continues wet all the month of March, it is too late to venture them after. It is much better to summer-fallow, and to sow wheat in the autumn. But the preferable method, especially in clay soil, is to turn over the field after harvest, and to lay it open to the influences of frost and air, which lessen the tenacity of clay, and reduce it to a free mould. The surface-soil by this means is finely mellowed for the reception of the seed ; and it would be a pity to bury it by a second ploughing before sowing. In general, the bulk of clay soils are rich ; and skilful ploughing without dung, will probably give a better crop, than unskilful ploughing with dung.

Hitherto of natural clays. We must add a word of carse clays which are artificial, whether left by the sea, or swept down from higher grounds by rain. The method commonly used of dressing carse clay for oats, is, not to stir it till the ground be dry in the spring, which seldom happens before the 1st of March,

and

Culture of particular Plants. and the seed is sown as soon after as the ground is sufficiently dry for its reception. Frost has a stronger effect on such clays than on natural clay. And if the field be laid open before winter, it is rendered so loose by frost as to be soon drenched in water. The particles at the same time are so small, as that the first drought in spring makes the surface cake or crust. The difficulty of reducing this crust into mould for covering the oat-seed, has led farmers to delay ploughing till the month of March. But we are taught by experience, that this soil ploughed before winter, is sooner dry than when the ploughing is delayed till spring; and as early sowing is a great advantage, the objection of the superficial crusting is easily removed by the first harrow above described, which will produce abundance of mould for covering the seed. The ploughing before winter not only procures early sowing, but has another advantage: the surface-soil that had been mellowed during winter by the sun, frost, and wind, is kept above.

The dressing a loamy soil for oats differs little from dressing a clay soil, except in the following particular, that, being less hurt by rain, it requires not high ridges, and therefore ought to be ploughed crown and furrow alternately.

Where there is both clay and loam in a farm, it is obvious, from what is said above, that the ploughing of the clay after harvest ought first to be despatched. If both cannot be overtaken that season, the loam may be delayed till the spring with less hurt.

Next of a gravelly soil; which is the reverse of clay, as it never suffers but from want of moisture. Such a soil ought to have no ridges; but to be ploughed circularly from the centre to the circumference, or from the circumference

circumference to the centre. It ought to be tilled after harvest: and the first dry weather in spring ought to be laid hold of to sow, harrow, and roll; which will preserve it in sap.

The culture of oats is the simplest of all. That grain is probably a native of Britain: it will grow on the worst soil with very little preparation. For that reason, as already noticed, before turnip was introduced, it was always the first crop upon land broken up from the state of nature.

Upon such land, may it not be a good method, to build upon the crown of every ridge, in the form of a wall, all the surface-earth, one sod above another, as in a fold for sheep? After standing in this form all the summer and winter, let the walls be thrown down, and the ground prepared for oats. This will secure one or two good crops; after which the land may be dunged for a crop of barley and graft-seeds. This method may answer in a farm where manure is scarce.

In Norfolk this kind of grain is much less cultivated than barley; and the only species observed by Mr Marshal is a kind of white oat, which grows quickly, and seems to be of Dutch extraction. Oats are cultivated occasionally on all kinds of soils, but more especially on cold heavy land, or on very light, unproductive, heathy soils. They most frequently succeed wheat, or ley ground barley: "but (says our author) there are no established rules respecting any part of the culture of this time-serving crop." The culture of the ground is usually the same with that of barley; the ground generally undergoing a winter fallow of three or four ploughings, though sometimes they are sown after one ploughing. They are more commonly sown above

Culture of particular Plants. above furrow than barley. The seed-time is made subservient to that of barley, being sometimes sooner and sometimes later than barley seed-time: and Mr Marshal observes, that he has sometimes seen them sown in June; it being observable, that oats sown late ripen earlier than barley sown at the same time. The quantity of seed in Norfolk is from four to five bushels per acre; but he does not acquaint us with the produce. He mentions a very singular method of culture

Method of ploughing down oats. sometimes practised in this county, viz. ploughing down the oats after they begin to vegetate, but before they have got above ground: which is attended with great success, even though the ground is turned over with a full furrow. By this method weeds of every kind are destroyed, or at least checked in such a manner as to give the crop an opportunity of getting above them. As the porosity communicated to the soil is excellently well adapted to the infant plants of barley; that grain probably might frequently receive benefit from this operation.

Wild oats a weed in the Vale of Gloucester. In the Vale of Gloucester, Mr Marshal observes, that the wild oat is a very troublesome weed, as well as in Yorkshire; and he is of opinion, that it is as truly a native of Great Britain as any other arable weed, and is perhaps the most difficult to be extirpated. It will lie a century in the soil without losing its vegetative quality. Ground which has lain in a state of grass time immemorial, both in Gloucester and Yorkshire, has produced it in abundance on being broken up. It is also endowed with the same seemingly instinctive choice of seasons and state of the soil as other seeds of weeds appear to have. Hence it is excessively difficult to be overcome; for as it ripens

before

before any crop of grain, it sheds its seeds on the soil, where the roughness of its coat probably secures it from birds. The only methods of extirpating this plant are fallowing, hoeing, and handweeding, where the last is practicable, after it has shot its panicle.

No oats are cultivated in the Vale of Gloucester; though the wild oat grows everywhere, as already said. Mr Marshal is of opinion that the soil is better adapted to oats than to barley. The reason he assigns for the preference given to the latter is, that in this part of the country the monks were formerly very numerous, who probably preferred ale to oaten cake.—He now, however, recommends a trial of the grain on the stronger cold lands in the area of the Vale, as they seldom can be got sufficiently fine for barley. The fodder from oats he accounts much more valuable than that from barley to a dairy country; and the grain would more than balance in quantity the comparative difference in price.

In the midland district the *Poland oat*, which was formerly in vogue, has now given place to the *Dutch* or *Friesland* kind. It is constantly sown after turf; one ploughing being given in February, March, or April. The seed-time is the latter end of March and beginning of April, from four to seven bushels an acre; the produce is in proportion to the seed, the medium being about six quarters.

In Yorkshire the Friesland oats are likewise preferred to the Poland, as affording more straw, and being thinner skinned than the latter. The *Siberian*, or *Tartarian* oat, a species unnoticed by Linnæus, is likewise cultivated in this country: the *reed* oat is known, but has not yet come into any great estimation. The

Culture of grain is light, and the straw too ready to be affected by cattle.

Singular method of thrashing.

Oats are particularly cultivated in the western division of the Vale of Yorkshire; where the soil is chiefly a rich sandy loam, unproductive of wheat. Five or six bushels, or even a quarter of oats, are sometimes sown upon an acre; the produce from seven to ten quarters. In this country they are thrashed in the open air, and frequently even upon the bare ground, without even the ceremony of interposing a cloth. The reasons assigned for this seemingly strange practice are, that if pigs and poultry be employed to eat up the grain which escapes the broom, there will be little or no waste. Here the market is always very great for new oats, the manufacturing parts of West Yorkshire using principally oat-bread. The only objection to this practice is the chance of bad weather; but there is always plenty of straw to cover up the thrashed corn, and it is found that a little rain upon the straw does not make it less agreeable to cattle.

Experiment on black oats. In an experiment made by Mr Bartley* near Bristol, upon black oats, we are informed that he had the prodigious increase of $98\frac{1}{2}$ Winchester bushels from four on the acre: the land was a deep, mellow, sandy loam. It had carried potatoes the former year, and received one ploughing for a winter fallow. Another ploughing was given it in February, and the seed was sown on the 27th and 28th of the month. The success of the experiment was supposed to be owing partly to the early sowing and partly to a good deep tillage.

3. BARLEY.

* *Bath Papers*, vol. iv. p. 281.

3. BARLEY.

This is a culmiferous plant that requires a mellow soil. Upon that account, extraordinary care is required where it is to be sown upon clay. The land ought to be stirred immediately after the foregoing crop is removed, which lays it open to be mellowed by the frost and air. In that view, a peculiar sort of ploughing has been introduced, termed *ribbing*; by which the Ribbing. greatest quantity of surface possible is exposed to the air and frost. The obvious objection to this method is, that half of the ridge is left unmoved. And to obviate that objection, the following method is offered, which moves the whole soil, and at the same time exposes the same quantity of surface to the frost and air. As soon as the former crop is off the field, let the ridges be gathered with as deep a furrow as the soil will admit, beginning at the crown and ending at the furrows. This ploughing loosens the whole soil, giving free access to the air and frost. Soon after, begin a second ploughing in the following manner: Let the field be divided by parallel lines across the ridges, with intervals of thirty feet or so. Plough once round an interval, beginning at the edges, and turning the earth toward the middle of the interval; which covers a foot or so of the ground formerly ploughed. Within that foot plough another round similar to the former; and, after that, other rounds, till the whole interval be finished, ending at the middle. Instead of beginning at the edges, and ploughing toward the middle, it will have the same effect to begin at the middle, and to plough toward the edges. Plough the other intervals in the same manner. As by this operation the furrows

PRACTICE OF

of the ridges will be pretty much filled up, let them be cleared and water-furrowed without delay. By this method, the field will be left waving like a plot in a kitchen garden, ridged up for winter. In this form, the field is kept perfectly dry; for besides the capital furrows that separate the ridges, every ridge has a number of cross furrows that carry the rain instantly to the capital furrows. In hanging grounds retentive of moisture, the parallel lines above mentioned ought not to be perpendicular to the furrows of the ridges, but to be directed a little downward, in order to carry rain water the more hastily to these furrows. If the ground be clean, it may lie in that state winter and spring, till the time of seed-furrowing. If weeds happen to rise, they must be destroyed by ploughing, or braking, or both; for there cannot be worse husbandry, than to put the seed into dirty ground.

Advantages of this method.

This method resembles common ribbing in appearance, but is very different in reality. As the common ribbing is not preceded by a gathering furrow, the half of the field is left untilled, compact as when the former crop was removed, impervious in a great measure to air or frost. The common ribbing at the same time lodges the rain-water on every ridge, preventing it from descending to the furrows; which is hurtful in all soils, and poisonous in a clay soil. The *slitting* here described, or *ribbing*, if you please to call it so, prevents these noxious effects. By the two ploughings the whole soil is opened, admitting freely air and frost; and the multitude of furrows lays the surface perfectly dry, giving an early opportunity for the barley-seed.—But further, as to the advantage of this method: When it is proper to sow the seed, all is laid flat with the

the brake, which is an easy operation upon soil that is dry and pulverized ; and the seed-furrow which succeeds is so shallow as to bury little or none of the surface earth : whereas the stirring for barley is commonly done with the deepest furrow ; and consequently buries all the surface soil that was mellowed by the frost and air. Nor is this method more expensive ; because the common ribbing must always be followed with a stirring furrow, which is saved in the method recommended. Nay, it is less expensive ; for after common ribbing, which keeps in the rain-water, the ground is commonly so soured, as to make the stirring a laborious work.

It is well known that barley is less valuable when it does not ripen equally ; and that barley which comes up speedily in a dusky soil, must gain a great advantage over seed-weeds. Therefore, first take out about one-third of the contents of the sacks of seed-barley or bear, to allow for the swelling of the grain. Lay the sacks with the grain to steep in clean water ; let it lie covered with it for at least 24 hours. When the ground is extremely dry, and no likelihood of rain for 10 days, it is better to lie 36 hours ; sow the grain wet from steeping, without any addition of powdered quicklime, which, though often recommended in print, can only poison the seed, suck up part of its useful moisture, and burn the hand of the sower. The seed will scatter well, as clean water has no tenacity ; only the sower must put in a fourth or a third more seed in bulk than is usual of dry grain, as the grain is swelled in that proportion : harrow it in as quickly as possible after it is sown ; and though not necessary, give

Culture of particular Plants. it the benefit of a fresh furrow, if convenient. You may expect it up in a fortnight at farthest.

It ought to be understood as a general principle, that of all preparations for barley, the best is a crop of turnips properly cultivated during the preceding year. Upon a clayey soil, however, it is absolutely necessary that these should not be consumed upon the field, on account of the additional tenacity which such a soil would acquire from being poached by the feet of cattle during wet weather. The dung in this case ought to be restored to the land. On lighter soils the turnip crop may be consumed in the field; though this is a practice by no means to be recommended where a contrary mode can conveniently be adopted.

The following experiment by a correspondent of the Bath Society being considered as a very interesting one, is here subjoined.

Important experiments on feed-barley

"The last spring (1783) being remarkably dry, I soaked my feed-barley in the black water taken from a reservoir which constantly receives the draining of my dung heap and stables. As the light corn floated on the top, I skimmed it off, and let the rest stand 24 hours. On taking it from the water, I mixed the seed grain with a sufficient quantity of sifted wood-ashes, to make it spread regularly, and sowed three fields with it. I began sowing the 16th, and finished the 23d of April. The produce was 60 bushels per acre, of good clean barley, without any *small* or *green* corn, or weeds, at harvest. No person in this country had better grain.

I sowed also several other fields with the same seed dry, and without any preparation; but the crop, like those of my neighbours, was very poor; not more than

twenty

twenty bushels per acre, and much mixed with *green* corn and weeds when harvested, I also sowed some of the seed dry on one ridge in each of my former fields, but the produce was very poor in comparison of the other parts of the field."

Where the land is in good order, and free of weeds, Time of April is the month for sowing barley. Every day is sowing. proper, from the first to the last.

The dressing loamy soil and light soil for barley, is the same with that described; only that to plough dry is not altogether so essential as in dressing clay soil. Loam or sand may be stirred a little moist: better, however, delay a week or two, than to stir a loam when wet. Clay must never be ploughed moist, even though the season should escape altogether. But this will seldom be necessary; for not in one year of 20 will it happen, but that clay is dry enough for ploughing some time in May. Frost may correct clay ploughed wet after harvest; but when ploughed wet in the spring, it unites into a hard mass, not to be dissolved but by very hard labour.

On the cultivation of this grain we have the following observations by a Norfolk farmer.

The best soil, he observes, is that which is dry and healthy, rather light than stiff, but yet of sufficient tenacity and strength to retain the moisture. On this kind of land the grain is always the best bodied and coloured, the nimblest in the hand, and has the thinnest rind. These are qualities which recommend it most to the maltster. If the land is poor, it should be dry and warm; and when so, it will often bear better corn than richer land in a cold and wet situation.

In the choice of your seed, it is needful to observe,

Culture of that the best is of a pale lively colour, and brightish particular Plants. cast, without any deep redness or black tinge at the tail.

If the rind be a little shrivelled, it is the better; for that slight shrivelling proves it to have a thin skin, and to have sweated in the mow. The necessity of a change of seed by not sowing two years together what grew on the same soil, is not in any part of husbandry more evident than in the culture of this grain, which, if not frequently changed, will grow coarser and coarser every succeeding year.

It has generally been thought, that seed-barley would be benefited by steeping; but liming it has, in many instances, been found prejudicial. Sprinkling a little foot with the water in which it is steeped has been of great service, as it will secure the seed from insects. In a very dry seed-time, barley that has been wetted for malting, and begins to sprout, will come up sooner, and produce as good a crop as any other.

If you sow after a fallow, plough three times at least. At the first ploughing, lay your land up in small ridges, and let it remain so during the winter, for the frost to mellow it; the second ploughing should be the beginning of February. In March split the ridges, and lay the land as flat as possible, at the same time harrowing it fine. But in strong wet lands (if you have no other for barley) lay it round, and make deep furrows to receive the water.

" I have often (continues he), taken the following method with success: On lands tolerably manured, I sowed clover with my barley, which I reaped at harvest; and fed the clover all the following winter, and from spring to July, when I fallowed it till the following spring, and then sowed it with barley and clover

as before. Repeating this method every year, I had very large crops, but would not recommend this practice on poor light land.

“ We sow on our lightest lands in April, on our moist lands in May; finding that those lands which are the most subject to weeds produce the best crops when sown late.

“ The common method is to sow the barley-seed broad-cast at two sowings; the first harrowed in once, the second twice; the usual allowance from three to four bushels per acre. But if farmers could be prevailed on to alter this practice, they would soon find their account in it. Were only half the quantity sown equally, the produce would be greater, and the corn less liable to lodge: For when corn stands very close, the stalks are drawn up weak; and on that account are less capable of resisting the force of winds, or supporting themselves under heavy rains.

“ From our great success in setting and drilling wheat, some of our farmers tried these methods with barley; but did not find it answer their expectations, except on very rich land.

“ I have myself had 80 stalks on one root of barley, which all produced good and long ears, and the grain was better than any other; but the method is too expensive for general practice. In poor land, sow thin, or your crop will be worth little. Farmers who do not reason on the matter will be of a different opinion; but the fact is indisputable.”

When the barley is sowed and harrowed in, he advises that the land be rolled after the first shower of rain, to break the clods. This will close the earth about

Culture of about the roots, which will be a great advantage to it
particular in dry weather.
Plants.

When the barley has been up three weeks or a month, it is a very good way to roll it again with a heavy roller, which will prevent the sun and air from penetrating the ground to the injury of the roots. This rolling, before it branches out, will also cause it to tiller into a greater number of stalks; so that if the plants be thin, the ground will be thereby filled, and the stalks strengthened.

If the blade grows too rank, as it sometimes will in a warm wet spring, mowing is a much better method than feeding it down with sheep; because the scythe takes off only the rank tops, but the sheep being fond of the sweet end of the stalk next the root, will often bite so close as to injure its future growth.

Cultivation
of barley in
Norfolk.

The county of Norfolk, according to Mr Marshal, is peculiarly adapted to the cultivation of this grain, the strongest soil not being too heavy, and the lightest being able to bear it; and so well versed are the Norfolk farmers in the cultivation of it, that the barley of this county is desired for feed throughout the whole kingdom. It is here sown after wheat or turnips, and in some very light lands it is sown after the second year's ley. After wheat, the seed-time of the latter being finished, and the stubble trampled down with bullocks, the land is ploughed with a shallow furrow for a winter fallow for barley. In the beginning of March the land is harrowed and cross-ploughed; or if it be wet, the ridges are reversed. In April it receives another ploughing lengthwise; and at seed-time it is harrowed, roiled, sowed, and the surface rendered as smooth and level as possible. After turnips the soil is broken

broken up as fast as the turnips are taken off; if early in winter by *rice-balking*, a practice already explained; but if late, by a plain ploughing. It is common, if time will permit, to plough three times; the first shallow, the second full, and the third a mean depth; with which last the seed is ploughed in. Sometimes, however, the ground is ploughed only once, and the seed sown above; but more frequently by three ploughings, though, perhaps, the farmer has not above a week to perform them in. After ley, the turf is generally broken by a winter fallow, and the soil treated as after wheat.

This grain is seldom manured for, except when sown after ley, when it is treated as wheat. No manure is requisite after turnips or wheat, if the latter has been manured for. If not, the turnip crop following immediately, the barley is left to take its chance, unless the opportunity be embraced for winter marling.

Little barley is sown by the Norfolk farmers before the middle of April, and the seed-time generally continues till the middle of May; though this must in some measure depend on the season; which, says Mr Marshal, is more attended to in Norfolk than perhaps in all the world besides." In the very backward spring of 1782, barley was sown in June with success. No preparation is used. It is all sown broadcast, and almost all under furrow; that is, the surface having been smoothed by the harrow and roller, the seed is sown and ploughed under with a shallow furrow; but if the season be wet, and the soil cold and heavy, it is sometimes sown above: but, if the spring be forward, and the last piece of turnips eaten off late, the ground is sometimes obliged

Culture of ~~Plants~~ to be ploughed only once, and to be sown above; though in this case Mr Marshal thinks it the most eligible management, instead of turning over the whole thickness of the soil, to *two-furrow* it, and sow between. This is done by only skimming the surface with the first plough, sowing the seed upon this, and then covering it with the bottom furrow brought up by the second plough. Three bushels are usually sufficient for an acre.

The barley, as well as the wheat, in Norfolk, is allowed to stand till very ripe. It is universally mown into swath, with a small bow fixed at the heel of the scythe. If it receive wet in the swath in this county, it is not turned, but *lifted*; that is, the heads or ears are raised from the ground, either with a fork or the teeth of a rake, thereby admitting the air underneath the swathes; which will not fall down again to the ground so close as before, so that the air has free access to the under side; and this method of lifting is supposed not to be inferior to that of turning, which requires more labour, besides breaking and ruffling the swathes.

In the Vale of Gloucester the quantity of barley cultivated is very inconsiderable; the only species is the common long-eared barley, (*hordeum saccharinum*). In this county the grain we speak of is used, on the every year's lands, as a cleansing crop. It is sown very late, viz. in the middle or end of May; sometimes the beginning or even the middle of June. The reason of this is, that the people of the Vale think, that if a week or ten days of fine weather can be had for the operation of harrowing out couch, and if after this a full crop of barley succeed, especially if it should fortunately

ly take a reclining posture, the business of fallowing is ^{Culture of particular Plants.} effectually done, insomuch that the soil is cleaned to a sufficient degree to last for a number of years. A great quantity of seed is made use of, viz. from three to four bushels to an acre; under the idea, that a full crop of barley, especially if it lodge, smothers all kinds of weeds, couch-grass itself not excepted. Our author acknowledges this effect in some degree, but does not recommend the practice. "If the land, says he, be tolerably clean, and the season favourable, a barley fallow may no doubt be of essential service. But there is not one year in five in which even land which is tolerably clean can be sown in season, and at the same time be much benefited by it for future crops." The barley in this county is all hand-weeded. It is harvested loose, mown with the naked scythe, lies in swath till the day of carrying, and is cocked with common hay forks. The medium produce is three quarters per acre. Its quality is preferable to that of the hill barley.

The common long-eared species is sown among the ^{In Cots. wold.} Cotswold hills. It is sown in the latter end of March and beginning of April, in the quantity of three bushels to an acre, producing from 20 bushels to four quarters to an acre; "which, says our author, is a low produce. It must be observed, however, that this produce is from land deficient in tillage; and that barley delights in a fine pulverous tilth."

In the midland district they cultivate two species of barley, viz. the *zeocriton* or common long-eared, and strict ^{In the mid-land di-} the *diflicbon*, or sprat barley; the latter not being of more than 50 years standing, but the former of much older date. The sprat is the more hardy, and requires

Culture of to be more early sown; but the long-ear yields the particular better produce. It succeeds wheat and turnips; but on the strong lands of this district, the crop after wheat is much less productive, as well as less certain, than after turnips; which circumstance is likewise observed in Norfolk. It is sometimes also sown with success upon turf. When sown after wheat, the soil is winter-fallowed by three ploughings; the first lengthwise in November; the second across in March; the last, which is the seed-ploughing, lengthwise. Between the two last ploughings the soil is harrowed, and the twitch shaken out with forks; after which it is left loose and light to die upon the surface, without being either burnt or carried off. After turnips the soil has commonly three ploughings; the reason of which is, that the turnips being commonly folded off with sheep, the soil, naturally of a close texture, receives a still greater degree of compactness, which it is proper to break down, to render it porous. The seed-time is the two last weeks of April and the first of May; from two bushels and a half to three bushels an acre, sometimes even as much as four bushels: the produce very great, sometimes as high as seven or even eight quarters an acre; but the medium may be reckoned from four to four and a half quarters. Mr Marshal remarks, that the culture of barley is extremely difficult. "Something," says he "depends on the nature of the soil, much on the preparation, much on the season of sowing and much on harvesting. Upon the whole, it may be deemed, of corn crops, the most difficult to be cultivated with certainty."

In York-shire.

In Yorkshire there are four kinds of barley cultivated, viz. the *zeocriton* or long-eared; the *diflacion*

or sprat; the *vulgare*, big, four-rowed or spring barley; and the *bexasticum*, six-rowed or spring barley. Culture of particular Plants.
 The first and third sorts are principally cultivated; the winter barley is as yet new to the district. Battledoor barley was formerly very common, but is now almost entirely disused. Mr Marshal observes, that less than a century ago, barley was not saleable until it was malted; there were neither maltsters nor public houses, but every farmer malted his own grain, or sold it to a neighbour who had a malt kiln. Brakes cut from the neighbouring commons were the fuel commonly used upon this occasion; and a certain day for cutting them was fixed, in order to prevent any one from taking more than his share. The case is now totally reversed, even public malt-houses being unknown, and the business of malting entirely performed by maltsters, who buy the barley from the farmer, and sell him what malt he may want for his family.

4. BUCK-WHEAT.

The uses of this plant have already been sufficiently noticed. It delights in a mellow sandy soil; but succeeds well in any dry loose healthy land, and moderately so in a free loamy stone brash. A stiff clay is its aversion, and it is entirely labour lost to sow it in wet poachy ground. The proper season for sowing is the last week of May or the beginning of June. It has been sown, however, so early as the beginning of April, and so late as the 22d of July, by way of experiment; but the latter was rather extreme to be chosen, and the former was in danger from frost. In an experiment upon a small piece of ground, the grain of two different crops was brought to maturity in the summer buck-wheat.

Culture of summer 1787.—After spring feedings, a crop of turnip-rooted cabbage, or vetches, there will be sufficient time to sow the land with buck-wheat. Probably, in hot dry summers, a crop of vetches might even be mown for hay early enough to introduce a crop of this grain after it.

In the year 1780, about seven acres of a sandy soil on Brislington common *, having been first tolerably well cleansed from brambles, furze, &c. received one ploughing. To reduce the irregularities of the surface, it was rolled; and on the 9th of June in that year, two bushels and a half of buck-wheat per acre sown, the ground rolled again without harrowing.

The vegetation appeared in five or six days, as is constantly the case, be the weather wet or dry. The growth was so rapid, that the fern, with which this land greatly abounded, was completely kept under. About the middle of September the crop was mown; but by reason of a great deal of rain about that time it was not secured until the beginning of October; hence a loss of a great part of the grain by shedding, as well as some eaten by birds. However, there were saved about 24 Winchester bushels per acre; and, notwithstanding its long exposure to the weather, it received no sort of damage, only perhaps that the finest and most perfect grain was the first to fall from the plant. The ground after this had almost the appearance of a fallow, and was immediately ploughed.

When it had lain a moderate time to meliorate, and to receive the influences of the atmosphere, it was harrowed,

* A very rough piece of land, at that time just enclosed.

^{Culture of particular Plants.}
rowed, sown with Lammas wheat, and ploughed in under furrow, in a contrary direction to the first ploughing. Thus a piece of land, which in the month of April was altogether in a state of nature, in the following November was seen under a promising crop of what is well styled the king of grain, and this without the aid of manure, or of any very great degree of tillage. Nor was the harvest by any means deficient; for several persons conversant in such things estimated the produce from 26 to 30 bushels per acre. As soon as the wheat crop was taken off, the ground had one ploughing, and on the first of September following was sown with turnip seed. The turnips were not large, but of an herbage so abundant as in the following spring to support 120 ewes with their lambs, which were fed on it by folding four weeks. After this it was manured with a composition of rotten dung and natural earth, about 20 putt loads per acre, and planted with potatoes. The crop sold for 138l. besides a considerable number used in the family, and a quantity reserved with which ten acres were planted the following season. The ensuing autumn it was again sown with wheat, and produced an excellent crop. In the spring of 1784, it was manured and planted with potatoes, as in the preceding instance; the crop (though tolerably good) by no means equal to the former, producing about 100 sacks per acre only. In spring 1785, the land was now for a third time under a crop of wheat, it being intended to try how far this mode of alternate cropping, one year with potatoes and another with wheat, may be carried.

From the success of the preceding and other experiments, by Nehemiah Bartley, Esq. of Bristol, as de-

Culture of tailed in the Bath Society Papers, it would seem, that particular **Plants.** the culture of this plant ought in many cases to be adopted instead of a summer-fallowing : for the crop produced appears not only to be so much clear gain in respect to such practice, but also affords a considerable quantity of straw for fodder and manure ; besides that a summer-fallowing is far from being so advantageous a preparation for a succeeding crop.

5. PEASE.

Culture of Pease are of two kinds ; the white and the gray. Pease. The cultivation of the latter only belongs, in strictness, to this place.

There are two species of the gray kind, distinguished by their time of ripening. One ripens soon, and for that reason is termed *hot feed* ; the other, which is slower in ripening, is termed *cold feed*.

Pease, a leguminous crop, is proper to intervene between two culmiferous crops ; less for the profit of a pease crop than for meliorating the ground. Pease, however, in a dry season, will produce six or seven bolls each acre ; but, in an ordinary season, they seldom reach above two, or two and a half. Hence, in a moist climate, which all the west of Britain is, red clover seems a more beneficial crop than pease ; as it makes as good winter food as pease, and can be cut green thrice during summer.

A field intended for cold feed ought to be ploughed in October or November ; and in February, as soon as the ground is dry, the seed ought to be sown on the winter furrow. A field intended for hot feed ought to be ploughed in March or April, immediately before sowing.

ing. But if infested with weeds, it ought to be also ploughed in October or November.

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Pease laid a foot below the surface will vegetate; but the most approved depth is six inches in light soil, and four inches in clay soil; for which reason, they ought to be sown under furrow when the ploughing is delayed till spring. Of all grains, beans excepted, they are the least in danger of being buried.

Pease differ from beans, in loving a dry soil and a ^{Horse-hoe-} dry season. Horse-hoeing would be a great benefit, could it be performed to any advantage; but pease grow expeditiouly, and soon fall over and cover the ground, which bars ploughing. Horse-hoeing has little effect when the plants are new sprung; and when they are advanced so as to be benefited by that culture, their length prevents it. Fast growing at the same time is the cause of their carrying so little seed: the seed is buried among the leaves; and the sun cannot penetrate to make it grow and ripen. The only practicable remedy to obtain grain, is thin sowing; but thick sowing produces more straw, and mellows the ground more. Half a bushel for an English acre may be reckoned thin sowing; three shillings thick sowing.

Notwithstanding what is said above, the late Mr Hunter, a noted farmer in Berwickshire, was accustomed to sow all his pease in drills; and never failed to have great crops of corn as well as of straw. He sowed double rows at a foot interval, and two feet and a half between the double rows, which admit horse-hoeing. By that method, he had also good crops of beans on light land.

Pease and beans mixed are often sown together, in order to catch different seasons. In a moist sea-

~~Culture of~~ son, the beans make a good crop; in a dry season, part clear the pease.

The growth of plants is commonly checked by drought in the month of July; but promoted by rain in August. In July, grass is parched; in August, it recovers verdure. Where pease are so far advanced in the dry season as that the seed begins to form, their growth is indeed checked, but the seed continues to fill. If only in the blossom at that season, their growth is checked a little; but they become vigorous again in August, and continue growing without filling till stopped by frost. Hence it is, that cold seed, which is early sown, has the best chance to produce corn: hot seed, which is late sown, has the best chance to produce straw.

The following method is practised in Norfolk, for sowing pease upon a dry light soil, immediately opened from pasture. The ground is pared with a plough extremely thin, and every sod is laid exactly on its back. In every sod a double row of holes is made. A pea dropt in every hole lodges in the flayed ground immediately below the sod, thrusts its roots horizontally, and has sufficient moisture. This method enabled Norfolk farmers, in the barren year 1740, to furnish white pease at 12s. per boll.

Experi-
ments on
setting
pease in
drills.

In the Bath Papers, vol i. p. 148. we have an account of the success of an experiment by Mr Pavier near Taunton, on sowing pease in drills. The scale on which this experiment was made, however, being so small, it would perhaps be rash to infer from it what might be the event of planting a large piece of ground in the same manner. The space was only 16 square yards, but the produce so great, that by calculating

ulating from it, a statute acre would yield 600, or at Culture of
the least 500 pecks of green pease at the first gather- particular
ing; which, at the high price they bore at that time Plants.
in the country about Taunton, viz. 16d. per peck,
would have amounted to £31. 6s. 8d. On this the So-
ciety observed, that though they doubt not the truth
of the calculation, they are of opinion, that such a
quantity as 500 or 600 pecks of green pease would
immediately reduce the price in any country market.
“ If the above-mentioned crop (say they) were sold only at nine pence per peck, the farmer would be well
paid for his trouble.” In a letter on the drill husbandry by Mr Whitmore, for which the thanks of the So-
ciety were returned, he informs us, that drilled pease
must not be sown too thin, or they will always be
foul: and in an experimet of this kind, notwithstanding
careful hoeing, they turned out so foul, that the
produce was only eight bushels to the acre.—From an Pease must
experiment related in the 5th volume of the same work, not be
it appears that pease, however meliorating they may often on
be to the ground at first, will at the last totally exhaust the same
spot. It, at least with regard to themselves. In this ex-
periment they were sown on the same spot for ten
years running. After the first two years the crop be-
came gradually less and less, until at last the seed would
not vegetate, but became putrid. Strawberries were
then planted without any manure, and yielded an ex-
cellent crop.

On the Norfolk culture of pease, Mr Marshal makes two observations. “ Leys are seldom ploughed more than once for pease; and the seed is in general dibbled in upon the flag of this one ploughing. But stubbles are in general broken by a winter-fallow of

^{Culture of} three or four ploughings; the seed being sown broad-particular
^{Plants.} cast and ploughed in about three inches deep with the last ploughing."—In the Vale of Gloucester they are planted by women, and hoed by women and children, once, twice, and sometimes thrice; which gives the crop, when the soil is sufficiently free from root-weeds, the appearance of a garden in the summer time, and produces a plentiful crop in harvest. The distance between the rows varies from 10 to 14 inches, but 12 may be considered as the medium; the distance in the rows two inches. In the Cheltenham quarter of the district, they set the pease not in continued lines, but in clumps; making the holes eight or ten inches distant from one another, putting a number of pease into each hole. Thus the hoe has undoubtedly greater freedom; all the disadvantage is, that in this case the soil is not so evenly and fully occupied by the roots as when they are disposed in continued lines.—In Yorkshire it is common to sow beans and gray pease together, under the name of *blendings*; and sometimes vetches (probably, says Mr Marshal, a gigantic variety of the *ervum lens*) are sown among beans. Such mixtures are found to augment the crop, and the different species are easily separated by the sieve.

Suffolk cul.
^{ture of} pease. A Suffolk farmer has given the following remarks upon the culture of pease, some of which are very worthy of attention. He enumerates eight kinds: "1. The common white. 2. The forty-day. 3. The Charlton. 4. The blue. 5. The large gray. 6. The small gray. 7. The speckled. 8. The large Dutch." Between the three

three first of these he represents the distinction as not very clear. "The gray hog pea, he adds, whether large or small, will bear being sown in autumn; a common practice in Hertfordshire, where they begin pea-sowing as soon as the wheat seed is over. The farmers, however, have distinctions, and think that some sorts will stand the winter, and that others will not; but I never could gain explicit information upon this head sufficient to overthrow my own practice: for I have sown them all in November more than once with success. The blue and speckled, I believe, are spring peas. All that I know of the Dutch is, that a person had them from Holland; they are as large as a horse-bean, and succeeded well with him.

" Of all other preparations for peas, that is best which admits the least tillage, viz. ley ground, with only one ploughing, the peas to be pricked in with iron dibblers, a common method in Suffolk, and which succeeds greatly; but it should be practised only on loams and good sand; very poor sand will not do for peas, and on clay beans answer far better. When this preparation is not followed, but the crop put in on a stubble, the land should be ploughed in autumn, and, if the season demands it, twice in the spring; but one ploughing, judiciously timed, may do better than two. The seed may be either ploughed or harrowed; if the former, it must not be above three inches deep; but harrowing in is safer, if the harrows let them in two inches. If harrowed in, they must be watched against rooks, &c.

" As no manuring should be given for peas, I pass on to the time of putting them into the ground; and here it is necessary to reject the autumnal sowing, when

Culture of the crop is to be harvested time enough for turnips.
particular
Plants. In that case, I recommend it only for dry lands. The
sort which are sown before Christmas are late pease,
which are not off soon enough for this purpose. The
forty-day, or the Charlton pea, should be sown early in
March; and if turnips are intended, not later than that
month. Late-sown crops are subject to the green fly.
If they are not intended as a preparation for turnips
then the time of sowing is before Christmas; but to
choose a dry time, for if they are sown soon after rain
or snow, the crop will suffer.

"I would never sow broad-cast less than three bushels
an acre of pease. One great object, perhaps the greatest
in this crop, is to procure a thick cover over the soil;
which, if thick enough, destroys weeds very effectually,
and breeds a moist putrid fermentation on the surface
of the land; this is never effected with a thin crop.
If you look only to the produce, and design to have the
hoes perpetually at work, two bushels and even less are
enough.

"Pease when ripe are very apt to be devoured by
rooks, wood-pigeons, and other birds; they should therefore
be well watched. The best way of cutting them
is with the tool called a pease-make, made with half an
old scythe; and, as cut, they are turned up into wads
or bundles, which should lie out some days to wither.
These wads should be small, for they do not dry well
when large. Pease are sometimes mown, but it is a very
bad practice.

Early pease are recommended by this writer as a
preparation for turnips. "By sowing the charlton or
forty-day pea early in March, they will be cleared from
the field within the month of June, or the first week of

July,

July, which is a very good season for turnips, and on all dry soils (the only ones proper for pease) ought never to be neglected. If the harvest happens to be later, the wads should be laid in rows, and the ploughs sent in without waiting for their being cleared away; by which a week or perhaps ten days may be gained. The advantages of this practice must be obvious, when it is considered that a thick smothering crop of pease, not only kills weeds, but improves the soil, and particularly in leaving the surface loose and friable from the putrefactive fermentation carried on under the pease, which retain moisture but exclude the sun; and if the land is ploughed directly, which is a great point, though much neglected by farmers in general, proves a fine preparation for turnips. The pease are not the only gain, but the saving in tillage; for by this means the latter crop is put in upon only one ploughing, which can be effected no other way."

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particular
Plants.

6. BEANS.

The properest soil for beans is a moist and deep clay, but they may also be raised upon all heavy soils. They are cultivated in two ways; either in the old way by broad-cast, or, according to the more recent practice, they are drilled in distinct rows. Of each of these we shall give a very short account.

When the mode of cultivating beans by broad-cast is adopted, it is to be observed, that as this grain is early sown, the ground intended for it should be ploughed before winter, to give access to the frost and air; beneficial in all soils, and necessary in a clay soil. Take the first opportunity after January, when the ground is dry, to loosen the soil with the harrow first described,

till

Culture of
beans by
broad-cast.

Culture of till a mould be brought upon it. Sow the seed, and particular Plants. cover it with the second harrow. The third will smooth the surface, and cover the seed equally. These harrows make the very best figure in sowing beans : which ought to be laid deep in the ground, not less than six inches. In clay soil, the common harrows are altogether insufficient. The soil, which has rested long after ploughing, is rendered compact and solid : the common harrows skim the surface : the seed is not covered ; and the first hearty shower of rain lays it above the ground. Where the farmer overtakes not the ploughing after harvest, and is reduced to plough immediately before sowing, the plough answers the purpose of the first harrow ; and the other two will complete the work. But the labour of the first harrow is ill saved ; as the ploughing before winter is a fine preparation, not only for beans, but for grain of every kind. If the ground ploughed before winter happen by superfluity of moisture to cake, the first harrow going along the ridges, and crossing them, will loosen the surface, and give access to the air for drying. As soon as the ground is dry, sow without delaying a moment. If rain happen in the interim, there is no remedy but patience till a dry day or two come.

Carfe clay, ploughed before winter, seldom fails to cake. Upon that account, a second ploughing is necessary before sowing : which ought to be performed with an ebb furrow, in order to keep the frost-mould as near the surface as possible. To cover the seed with the plough is, with regard to this as well as other grain, expressed by the phrase *to sow under furrow*. The clods raised in this ploughing are a sort of shelter to the young plants in the chilly spring months.

Thc

The foregoing method will answer for loam. And as for a sandy or gravelly soil, it is altogether improper for beans.

Previous to the year 1770, beans were seldom sown in Scotland, unless upon the very rich clays; but since that time, by adopting the plan of raising them in drills, or distinct rows, they have been successfully cultivated upon all the heavy loams, and in many farms they now constitute a regular branch of rotation. With very few exceptions, beans are constantly drilled at intervals of from 20 to 27 inches. Of these modes, the last is the most prevalent, because it admits the ground to be ploughed with a horse, in the most sufficient manner. Very little hand-hoing is given; nor is it required, as the kind of land which is best adapted for their growth, and upon which they are commonly sown, has not naturally a tendency to the production of annual weeds; and fine crops of wheat generally follow, provided due attention has been given to working the bean crop. The necessity of summer fallow, which the present high price of labour, and the loss of a year's crop, render an expensive affair to the farmer, is consequently much lessened: for if land is once thoroughly cleaned, and afterwards kept in an alternate course of leguminous and culmiferous crops, it will remain in good order for a considerable number of years.

As beans delight in a moist soil, and have no end of growing in a moist season, they cover the ground totally when sown broad-cast, keep in the dew, and exclude the sun and air: the plants grow to a great height; but carry little seed, and that little not well ripened. This displays the advantage of drilling;

which

Culture of which gives free access to the sun and air, dries the particular ground, and affords plenty of ripe seed.

The following remarks upon the subject made by Mr Vancouver * are also worthy of attention. "The land upon which pease or tares may be cultivated to advantage, does not require to possess so deep a staple as that appropriated to the culture of beans; the seed of which, in most soils, be their texture what it may, should never be deposited at a less depth than five or six inches below the settled surface of the ground. The necessity for placing the bean thus deep, will appear very obvious to any one who will take the trouble to inspect the root of the bean, when the plant has attained to its full growth, and its seed to its complete maturity; it will then appear evident, that from the point where the seed was deposited in the ground it sends downwards a long slender tap root, and upwards a thick strong one; along this upper division of the root, lateral fibres are detached from the seed to the surface of the ground, and are evidently destined to collect and convey nourishment to the plant. The long tap-root which descends perpendicularly, and to a great depth from the point where the seed was placed in the ground, being perfectly clear of laterals, will not be supposed to contribute but in a small degree to the growth and subsistence of the plant. Hence the necessity of placing the bean to a proper depth in the ground, that the plant may not be deprived of its proper organs for receiving and conveying from the earth that portion of nourishment which the bean requires; but which, as well as in the case of

pease

* *Annals of Agriculture*, vol. xxv.

pease or tares, will not be found equal to that constantly demanded and drawn from the land by turnips, cabbages, and the white straw crops.

Culture of particular Plants

II. *Plants Cultivated for Roots.*

I. POTATOES.

THESE, next to the different kinds of grain, may be looked upon as the crop most generally useful for the husbandman; affording not only a most excellent food for cattle, but for the human species also.

In this last respect, indeed, they are extremely valuable. They are the only substitute for bread formed of grain which has hitherto been introduced with any tolerable degree of success. They assume by the assistance of cookery such a variety of forms as renders them at all times extremely acceptable; and they are now justly regarded by the public as the surest resource in all times of scarcity, chiefly for this reason, that in the British islands, surrounded as they are by the waters of the ocean, the crop of grain is chiefly found to fail in consequence of wet seasons, which do by no means affect the potato in the same degree.

Various kinds of potatoes have at different periods been fashionable, and the varieties which the species is capable of exhibiting seems unbounded, as every person who takes the trouble to raise them from the seed discovers new sorts. In selecting the kind which he is to rear, the husbandman ought to consider the use that he is to make of them. If his lands are situated at a distance from any town, which may prevent his crop from being sold for human use, and confine it to the consumption of cattle, he will probably derive most benefit

PRACTICE OF

~~the~~ from planting the coarse dark red kind of potatoes ~~which~~, which afford a very great produce. They are extremely valuable for milch cows, increasing the produce without affecting the quality or taste of the milk; they grow on poor soils even more abundantly than on rich, (where they are apt to run too much to ~~them~~, and to be less productive at the root) and from the constant verdure which they retain to the latest period of the season, they are highly valuable in improving the state of the soil.

In the choice of potatoes intended to be consumed by man, the husbandman ought to attend to this quality of the potato, that the kinds which afford the most valuable and abundant crop at the root are apt to send forth the least luxuriant stems, while those whose stems are very large and branched are less productive at the root. Thus the kidney potato, which is much valued on account of its quality, and which on a rich soil is extremely prolific, is apt to send out a very feeble stem, which affords little or no covering to the soil, on which account some of the most judicious husbandmen have laid it aside.

The choice of soil is not of greater importance in any other plant than in a potato. This plant in clay soil, or in rank black loam lying low without ventilation, never makes palatable food. In a gravelly or sandy soil, exposed to the sun and free air, it thrives to perfection, and has a good relish. But a rank black loam, though improper to raise potatoes for the table, produces them in great plenty; and the product is, as already observed, a palatable food for horned cattle, dogs, and poultry.

The spade is a proper instrument for raising a small quantity

quantity, or for preparing corners or other places inaccessible to the plough; but for raising potatoes in quantities, the plough is the only instrument.

Culture of particular Plant.

As two great advantages of a drilled crop are, to destroy weeds, and to have a fallow at the same time with the crop, no judicious farmer will think of raising potatoes in any other way. In September or October, as soon as that year's crop is removed, let the field have a roasting farrow, a cross-braking next, and then be cleared of weeds by the cleaning harrow. Form it into three-feet ridges, in that state to lie till April, which is the proper time for planting potatoes. Cross-brake it, to raise the furrows a little. Then lay well digested horse-dung along the furrows, upon which lay the roots at eight inches distance. Cover up these roots with the plough, going once round every row. This makes a warm bed for the potatoes; hot dung below, and a loose covering above, that admits every ray of the sun. As soon as the plants appear above ground, go round every row a second time with the plough, which will lay upon the plants an additional inch or two of mould, and at the same time bury all the annuals; and this will complete the ploughing of the ridges. When the potatoes are six inches high, the plough, with the deepest furrow, must go twice along the middle of each interval in opposite directions, laying earth first to one row, and next to the other. And to perform this work a plough with a double mouldboard will be more expeditious. But as the earth cannot be laid close to the roots by the plough, the spade must succeed, with which four inches of the plants must be covered, leaving little more but the tops above ground; and this operation will at the same time bury all the weeds that have

^{Culture of} have sprung since the former ploughing. What weeds ^{particular} arise after must be pulled up with the hand. A hoe ^{Plants.} is never to be used here: it cannot go so deep as to destroy the weeds without cutting the fibres of the plants; and if it skim the surface, it only cuts off the heads of the weeds, and does not prevent their pushing again.

^{Particular}
^{Methods}

In the Bath Society Papers, we have the following practical observations on the culture and use of potatoes, given as the result of various experiments made for five years successively on that valuable root, the growth of which cannot be too much encouraged.

When the potato crop has been the only object in view, the following method is the most eligible.

The land being well pulverized by two or three good harrowings and ploughings, is then manured with 15 or 20 cart loads of dung per acre, before it receives its till earth. Then it is thrown into what the Suffolk farmers call the *trench balk*, which is narrow and deep ridge-work, about 15 inches from the centre of one ridge to the centre of the other. Women and children drop the sets in the bottom of every furrow 15 inches apart; men follow and cover them with large hoes, a foot in width, pulling the mould down so as to bury the sets five inches deep; they must receive two or three hand-hoeings, and be kept free from weeds; always observing to draw the earth as much as possible to the stems of the young plants. By repeated trials, the fall or second week in April is found the most advantageous time for planting.

In the end of September or the beginning of October, when the haulm becomes withered, they should be ploughed up with a strong double-breasted plough.

The workman must be cautioned to set his plough very deep, that he may strike below all the potatoes, to avoid damaging the crop. The women who pick them up, if not carefully attended to, will leave many in the ground, which will prove detrimental to any succeeding corn, whether wheat or barley. To avoid which inconvenience, let the land be harrowed, and turn the swine in to glean the few that may be left by their negligence.

Culture of
particular
Plants.

By this method, the sets will be 15 square inches from each other; it will take 18 bushels to plant an acre; and the produce, if on a good mixed loamy soil, will amount to 300 bushels.

If the potatoes are grown as a preparation for wheat, it is preferable to have the rows two feet two inches from each other, hand-hoeing only the space from plant to plant in each row; then turning a small furrow from the inside of each row by a common light plough, and afterwards, with a double-breasted plough with one horse, split the ridge formed by the first ploughing thoroughly to clean the intervals. This work should not be done too deep the first time, to avoid burying the tender plants; but the last earth should be ploughed as deep as possible; and the closer the mould is thrown to the stems of the plants, the more advantageous it will prove. Thus 15 bushels will plant an acre, and the produce will be about 300 bushels; but the land, by the summer ploughings, will be prepared to receive seed-wheat immediately, and almost ensure a plentiful crop.

The potato sets should be cut a week before planting, with one or two eyes to each, and the pieces not very small; two bushels of fresh-flaked lime should be

To prevent
the grub.

VOL. I. L 1 sown

Culture of fown over the surface of the land as soon as planted, which will effectually prevent the attacks of the grub.

particular Plants. The expence attending an acre of potatoes well cultivated in the first method, supposing the rent 20 shillings, tithe and town charges rather high (as in Suffolk), taking up, and every thing included, will be about 6l. In the last method, it would be somewhat reduced.

A premium having been offered by the above-mentioned society for the cultivation of potatoes by farmers, &c. whose rent does not exceed 40l. per annum, the following methods were communicated, by which those who have only a small spot of ground may obtain a plentiful crop.

Methods of cultivating potatoes on small spots First, then, the earth should be dug 12 inches deep, if the foil will allow of it; after this, a hole should be opened about six inches deep; horse dung or long litter should be put therein about three inches thick: this hole should not be more than 12 inches in diameter. Upon this dung or litter a potato should be planted whole, upon which a little more dung should be cast, and then earth must be put thereon. In like manner the whole plot of ground must be planted, taking care that each potato be at least 16 inches apart; and when the young shoots make their appearance, they should have fresh mould drawn round them with a hoe; and if the tender shoots are covered, it will prevent the frost from injuring them: they should again be earthed when the shoots make a second appearance, but not be covered, as in all probability the season will then be less severe. A plentiful supply of mould should be given them, and the person who performs this business should never tread upon the plant, or the hillock that

is

is raised round it ; as the lighter the earth is, the more room the potato will have to expand. From a single root thus planted, very near 40 pounds weight of large potatoes were obtained, and from almost every other root upon the same plot of ground from 15 to 20 pounds weight ; and except the soil be stony or gravelly, 10 pounds or half a peck of potatoes may almost always be obtained from each root, by pursuing the foregoing method. But note, cuttings or small sets will not do for this purpose.

The second method will suit the indolent, or those who have not time to dig their ground ; and that is, where weeds much abound and have not been cleared in the winter, a trench may be opened in a straight line the whole length of the ground, and about six inches deep ; in this trench the potatoes should be planted about ten inches apart ; cuttings or small potatoes will do for this method. When they are laid in the trench, the weeds that are on the surface may be pared off on each side about ten inches from it, and be turned upon the plants ; another trench should then be dug, and the mould that comes out of it turned carefully on the weeds. It must not be forgot, that each trench should be regularly dug, that the potatoes may be throughout the plot 10 or 12 inches from each other. This slovenly method will in general raise more potatoes than can be produced by digging the ground twice, and dibbling in the plants ; and the reason is, that the weeds lighten the soil, and give the roots room to expand. They should be twice hoed, and earthed up in rows. And here note, that if cut potatoes are to be planted, every cutting should have two eyes, for though fewer sets will be obtained, there will be a greater certainty

Culture of tainty of a crop, as one eye often fails or is destroyed
particular Plants by grubs in the earth.

Where a crop of potatoes fails in part (as will sometimes be the case in a dry season), amends may still be made by laying a little dung upon the knots of the straw or haulm of those potatoes that do appear, and covering them with mould: each knot or joint thus ordered will, if the weather prove wet afterwards, produce more potatoes than the original roots.

From the smallest potatoes planted whole, from four to six pounds at a root were obtained, and some of the single potatoes weighed near two pounds. These were dug in as before mentioned, in trenches where the ground was covered with weeds, and the soil was a stiff loamy clay.

Lazy beds. A good crop may be obtained by laying potatoes upon turf at about 12 or 14 inches apart, and upon beds of about six feet wide; on each side of which a trench should be opened about three feet wide, and the turf that comes from thence should be laid with the grassy side downwards upon the potatoes; a spit of mould should next be taken from the trenches, and be spread over the turf; and in like manner the whole plot of ground that is designed to be planted must be treated. And remark, that when the young shoots appear, another spit of mould from the trenches should be strewed over the beds so as to cover the shoots; this will prevent the frost from injuring them, encourage them to expand, and totally destroy the young weeds; and when the potatoes are taken up in the autumn, a careful person may turn the earth again into the trenches, so as to make the surface level; and it will be right



right to remark, that from the same ground a much better crop of potatoes may be obtained the following year. Culture of particular Plants

For field planting, a good (if not the best) method is to dung the land, which should be once ploughed previous thereto; and when it is ploughed a second time, a careful person should drop the potato plants before the plough in every third furrow at about eight or ten inches apart. Plants that are cut with two eyes are best for this purpose. The reason for planting them at so great a distance as every third furrow, is, that when the shoots appear, a horse-hoe may go upon the two vacant furrows to keep them clean; and after they are thus hoed, they should be moulded up in ridges; and if this crop be taken up about October or November, the land will be in excellent condition to receive a crop of wheat. Lands that are full of twitch or couch-grass may be made clean by this method, as the horse-hoeing is as good as a summer fallow; and if, when the potatoes are taken up, women and children were to pick out such filth, not any traces of it would remain; and by laying it on heaps and burning it, a quantity of ashes would be produced for manure.

After ploughing, none should ever dibble in potatoes, as the persons who dibble, plant, or hoe them, will all tread the ground; by which means it will become so bound, that the young fibres cannot expand, as has been already observed. Good crops have indeed been obtained by ploughing the land twice, and dropping the plants in every other furrow, and by hand-hoeing and earthing them up afterwards as the gardeners do pease; but this method is not equal to the other.

Vacant places in hedge-rows might be grubbed and
L 1 3 planted

Culture of planted with potatoes, and a good crop might be expected, as the leaves of trees, thorns, &c. are a good manure, and will surprisingly encourage their growth, and gratify the wishes of the planter; who by cultivating such places, will then make the most of his ground, and it will be in fine order to receive a crop of corn the following year.

Best method of taking them up.

The shortest and most certain method of taking up potatoes, is to plough once round every row at the distance of four inches, removing the earth from the plants, and gathering up with the hand all the potatoes that appear. The distance is made four inches, to prevent cutting the roots, which are seldom found above that distance from the row on each side. When the ground is thus cleared by the plough, raise the potatoes with a fork having three broad toes or claws; which is better than a spade, as it does not cut the potatoes. The potatoes thus laid above ground must be gathered with the hand. By this method scarce a potato will be left.

Of preserving them.

As potatoes are a comfortable food for the common people, it is of importance to have them all the year round. For a long time, potatoes in Scotland were confined to the kitchen garden; and after they were planted in the field, it was not imagined at first that they could be used after the month of December. Of late years, they have been found to answer even till the succeeding crop has arrived at maturity, which has proved a great support to many a poor family, as they are easily cooked, and proverbially require neither kiln nor mill. When taken out of the ground, lay in the corner of a barn a quantity that may serve till April, covered from frost with dry straw pressed down:

down : bury the remainder in a hole dug in dry ground, mixed with the husks of dried oats, sand, or the dry leaves of trees, over which build a stack of hay or corn. When the pit is opened for taking out the potatoes, the eyes of what have a tendency to push must be cut out ; and this cargo will serve all the month of June. To be still more certain of making the old crop meet the new, the setting of a small quantity may be delayed till June, to be taken up at the ordinary time before frost. This cargo having not arrived to full growth, will not be so ready to push as what are set in April.

If the old crop happen to be exhausted before the new crop is ready, the interval may be supplied by the potatoes of the new crop that lie next the surface, to be picked up with the hand ; which, far from hurting the crop, will rather improve it.

In the Transactions of the Society for the encouragement of Arts, a number of experiments are related by Mr Young on that kind called the *clustered* or *bog potato*, which he strongly recommends as food for the poor, in preference to the kidney or other more expensive kinds. The following is the result of the most remarkable of his experiments.

In the first week of March 1780, two acres and a quarter of barley stubble were sown with the cluster potato, which appeared on the 23d of May. A sharp frost on the 7th of June turned them as black as they usually are by the frosts of November and December. In time, however, they recovered ; and by the end of October produced 876 bushels from the $2\frac{1}{4}$ acres ; which, when cleaned, were reduced to 780, or 350 bushels per acre ; thus affording, when valued only at

Culture of 6d. per bushel, a clear profit of 7l. 14s. 4d. per acre.
particula
Plants. The experiment, however, in his opinion, would have
been still more profitable, had it not been for the following circumstances: 1. The soil was not altogether proper. 2. The crop was grievously injured by the frost already mentioned, which, in our author's opinion, retarded the growth for about six weeks. 3. The dung was not of his own raising, but purchased; which cannot but be supposed to make a great difference, not only on account of the price, but likewise of the quality, as happened to be the case at present. He is of opinion, however, that potatoes, at least this kind of them, are an exhausting crop. Having sown the field after this large crop of potatoes with wheat, his neighbours were of opinion that it would be too rank; but so far was this from being the case, that the wheat showed not the least sign of luxuriance, nor the least superiority over the parts adjacent which were sown without dung. He was willing to account for this by the poverty of the dung, and the severe cropping which the ground had undergone while in the possession of the former tenant. In another experiment, however, in which the ground had been likewise exhausted by severe cropping, the succeeding crop of wheat showed no luxuriance; so that the former suspicion of the exhausting quality of the cluster potato was rather confirmed. The ground was a fine turnip loam; but though the produce was even greater than in the former case, viz. 356 bushels from an acre, the profit was much less, viz. only 4l. 15s. 6d. An acre of ley ground was sown at the same time with the turnip loam, but the produce from it was only 200 bushels. Mr Young supposes that the produce would have been greater if the potatoes had been

been planted with an iron dibble, as the turf, in ploughing, lay too heavy upon the seed. A few rows of other potatoes, planted along with the clustered kind, did not vegetate at all; which shows that the latter have a more powerful vegetative faculty.

Having succeeded so well with his experiments on this kind of potato hitherto, Mr Young determined to try the culture of them upon a larger scale: and therefore, in the year 1782, sowed 11 acres: but being obliged to commit the care of sowing them to an ignorant labourer, his unskilfulness, together with the excessive cold and moisture of that season, so diminished the produce, that he had only a single acre out of the whole. This produced 180 bushels, which yielded of clear profit 4l. 2s. 6d. From this experiment he draws the following conclusions: 1. "That the poor loam, on which these potatoes were sown, will yield a crop of cluster-potatoes, though not of any other kind. 2. That the manure for potatoes ought to be carted and spread upon all soils inclinable to wet before the planting season, either in autumn preceding, or else during a hard frost." In 1783 he succeeded still worse; for having that year sown three acres and a half, the profit did not exceed 11s. 4d. per acre. The produce was about 224 bushels per acre. He gives two reasons for the failure of this crop: 1. The clustered potato thrives best in wet years; but the summer of 1783 was dry and hot. 2. The spring frost, by interrupting the hoeing, not only greatly raised the expences, but very much injured the crop by encouraging the growth of weeds. Barley was sown after the last crop, and produced well; so that our author thinks the potatoes seem to be a better preparation for spring corn than wheat.

Culture of wheat. His experiment in 1784 produced a clear particular profit of 2l. os. 4d.; the produce being 250 bushels per acre. Still, however, an error was committed, by employing an old man and woman to cut the sets, by whose unskillfulness there were many great gaps among the potatoes as they came up; so that, on the whole he reckons that he thus lost from 500 to 800 bushels.

Conclusion favourable to the cultivation of this kind. On the whole, however, his opinion is favourable to the cluster potato. "With small crops (says he), and at the low rate of value which is produced by consuming them at home, they are clearly proved to be a crop which will pay the expence of manuring, and very ample tillage and hoeing. This is, after all, the chief object of modern husbandry; for if a man can rely upon this potato for the winter consumption of his yard in fattening or keeping hogs, in feeding his horses, and fattening his bullocks, he has made one of the greatest acquisitions that can be desired; since he can do all this upon land much too stiff and wet for turnips; houses his crops before the winter rains come on; and consequently without doing any of that injury to his land which the turnip culture is known to entail, and from which even cabbages are not free. Those who know the importance of winter food on a turnip farm, cannot but admit the magnitude of this object on wet soils."

Board of Agriculture's rules of culture.

In consequence of the threatened scarcity in 1795, the Board of Agriculture circulated some hints respecting the culture of potatoes, which deserve attention. Concerning the sorts which ought to be planted, it was observed, "1st, That the sorts should not be liable to the *curl*; and, 2d, That they should be mealy. The kind known under the name of the *champion* has those qualities,

qualities, and is also very early and productive. The ox-noble is hardy, keeps well, and in the spring boils mealy. The kidney is of an excellent quality; and though the crop is less productive, and in some soils liable to curl, the price at market is proportionably great. The Surinam, cluster, or yam, so well calculated for stock, never curls, and is extremely productive. Those who cultivate potatoes on a great scale ought to have different sorts—for early use—for keeping—for stock."

" The modes of planting are, 1st, Drilling on land already in tillage. 2d, Dibbling upon grass or leys. 3d, Lazy bed on bogs, wet peat moor, and lands too rough to plough.

" *Drilling.*—Soils liable to be wet during the winter should be ploughed in autumn so as to lie dry. In the spring plough and harrow flat. In April and May the sets may be planted. Draw furrows three feet asunder; in those furrows lay the dung, not less than twenty loads or tons per acre. Drop the sets on the manure nine inches asunder. If the land be at all stiff, cover the dung and sets, by drawing earth over them with hand-hoes; adding more, afterwards, with the plough: if it be light and friable, it may be covered with the plough. Keep the intervals clean by ploughing or horse-hoeing for six or eight weeks after the potatoes appear; afterwards by hand-hoeing. Hand-hoe the rows when young, and afterwards weed them. Take up the crop by opening the rows with a plough, and harrow and pick them more than once.

" Lands prepared and dunged for wheat, that could not be sown on where the plant has been destroyed by the

Culture of the frost, are ready, without further manuring to receive particular plants potatoes in this mode of culture.

Dibbling.—If the soil of the grafts be very rich, it will want no manure: if moderately good, only ten or twelve tons per acre. If no manure be spread, plough late in autumn, and scuffle or skim the surface shallow; or, for want of those tools, if weeds or grafts arise, hand-hoe it in March. If manure be used, spread it on the ley in spring, and plough it in: in either case dibble in the sets straight on the centre of every other furrow, nine inches from plant to plant. Keep clean by hand-hoeing; but a narrow skim may be passed twice along the intervals. Weed the rows, if necessary. When the crop is taken up, plough across the former furrows.

“ This method is applicable also to dry moors and wastes capable of being ploughed; and by paring and burning the surface during the drying and north-east winds of March dung may be saved. To add lime in such cases, to the ashes, is beneficial.

“ After an early crop of grass for hay, or after the first crop of clover, the land may be ploughed, and potatoes dibbled in, if proper sets have been preserved for that purpose; and in the more southern parts of the island a good crop may be obtained.

Culture by lazy beds.—Upon bogs, partially or wholly drained, and upon such rough soils as are difficult to plough, this method may be adopted. Pare and burn the surface; add lime to the ashes. Strike the lands into straight beds, six feet wide, with intervals of two feet or two and a half. Lay the sets twelve inches square on the beds, and cover them two or three inches deep, with spades from the intervals: when the plants appear, cover

cover them again in the same manner one and a half or two inches more. Keep them clean by one hand-hoeing and successive weeding. They may be taken up with the plough, by splitting the beds, and filling the former intervals, converting the open furrows left of the centre of the former beds, into drains deep enough to leave the land dry in winter.

“ Produce.”—In any of these methods the farmer may produce. Culture of particular Plants.
expect from 200 to 300 bushels an acre, of 75 lb. per bushel; some soils will yield more, and some may afford less. The drill method is by much the cheapest. If the whole should not be saleable, the rest may be given to fatten oxen, to horses, and to any other live-stock, with advantage; particularly if, when boiled or steamed, a handful of salt be added to two bushels of potatoes.

“ Double crops.”—In Cornwall, in Cheshire, in Lancashire, and in the neighbourhood of London, two crops have been obtained from the same ground in one year: the mode of raising which will be found in the Agricultural Reports from the counties of Cheshire and Lancashire. Those who raise early potatoes may certainly have a second crop on the same ground.

“ The following crop.”—Wheat has been sown with The succeeding crop. success after potatoes; but barley or oats are more to be recommended. On dry moory soils, treated as above, turnips may follow, fed off by sheep, and these by spring corn and grafts.

“ Preservation.”—The most approved method is that Mode of preservation. of digging in a very dry spot, trenches six feet wide, and eighteen inches deep; spread straw; pile the potatoes into the shape of the roof of a house; cover tight and close with straw six inches thick; and then with earth

Culture of fifteen to eighteen inches more; fluted regularly and
particular firmly, and sharp at top; raised from three feet to five
~~feet~~ feet above ground. If there shall be any apprehension
of moisture, dig a trench a few yards off deeper than
that in which the roots are laid. The drier they are,
when thus packed up, the safer they will be."

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Mr Marshal in his *Rural Economy of Yorkshire*, has several very interesting remarks on the potato. Its varieties, he says, are endless and transitory. The rough-skinned Russia potato, which was long a favourite of the Yorkshire farmers, he is of opinion, has now no longer an existence, more than many others which flourished for a time. "There is some reason to believe (says he) that the disease which has of late years been fatal to the potato crop in this and in other districts under the name of *CURLED TOPS*, has arisen from too long a continuance of declining varieties. Be this as it may, it appears to be an established opinion here, that *fresh varieties*, raised from seed, are not liable to that disease." Our author, however, does not look upon this to be a fact absolutely established: though one instance fell under his observation, in which its removal was in all probability owing to the introduction of new varieties. It made its appearance between 40 and 50 years ago, and spread in some degree over the whole kingdom. In some places it continued but a short time, so that its effects are almost forgotten. It is seldom obvious at the first coming up of the plants, but attacks them as they increase in size; the entire top becoming dwarfish and shrivelled, as if affected by drought or loaded with insects: they nevertheless live and increase, though slowly, in size; but the roots are unproductive. Some crops have been almost wholly destroyed

destroyed by this disease. In Yorkshire the Morelands are in a manner free from it, but the Vale is in some measure infected. Plants procured from the Morelands remain free from it in the Vale the first year; but, being continued, become liable to the disease. Where the attack has been partial, weeding out the diseased plants, as they failed, is said to have had a good effect; and it is said that the Morelanders got rid of the disease by this means.

Culture of
particular
Plants.

In Yorkshire some intelligent husbandmen are acquainted with the method of raising potatoes from seed; which is as follows: "In autumn, when the apples are beginning to fall spontaneously, they are gathered by hand, and preserved among sand until the spring, when they are mashed among sand or among fresh mould; separating the seeds and mixing them evenly with the mould. As soon as the spring frosts are judged to be over, they are sown in fine garden mould; and as fast as the plants get into rough leaf, and are strong enough to be handled without injury, they are transplanted into another bed of rich mould in rows, which are kept clean during summer. In autumn, bunches of small potatoes are found at the roots of these plants, varying in size, the first year, from a hazel nut to that of a crab. These being planted next spring, produce potatoes of the middle size; but they do not arrive at their fullest bulk until the third or fourth year. Where the use of the stove or the garden frame can be had, this process may be shortened. The seeds being sown within either of these early in the spring, the plants will be fit to be planted out as soon as the frosts are gone; by which means the size of the roots

Culture of roots will be much increased the first year, and will in particular Plants. the second rise early to perfection."

Another account of the mode of raising potatoes from seed is given by Mr Henry Doby of Woodside Chapel, Allerton, near Leeds *. "Take the largest potato apples, of the kind you wish to renew, and string them on a very strong coarse thread, and hang them in a dry warm place till the latter end of February; when breaking them very small and washing them in several waters, the seed is to be separated from the fleshy part and skins; this done, it should be spread on brown paper; and when dry, sow it in the beginning of March, or sooner, on a hot-bed, in lines about nine inches asunder, and one-third of an inch deep, and very thin: water between the lines frequently, and when the plants are risen a little height, introduce fine rich earth between the lines to strengthen them. They should have air admitted frequently, the better to enable them to bear being removed into the open air as soon as the weather shall be sufficiently temperate. Before they are transplanted they should be plentifully watered to make them rise with a large ball at their roots; old rotten horse-dung and yellow moss are the best manures; plant them in trenches, as celery was formerly, with a space of four feet between the trenches, and 12 or 14 inches between each plant; as they grow up, draw the earth between the trenches to the stalks, but do not cover their tops. The ground, when brought to a level, should be dug, and the plants earthed until there are pretty deep trenches formed between the lines.

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* *Annals of Agriculture*, vol. xix.

With this treatment they will produce the first season from a pound weight to five pounds a plant ; and many of the plants considerably more than a hundred potatoes a-piece ; the produce of which for ten or twelve years after will be prodigious." Culture of particular Plants.

In the 4th volume of the Bath Papers, Dr Anderson relates some experiments made on potatoes raised from seed. The first year they were of different sizes, from a pigeon's egg to that of a small pea. On planting these next year, it was invariably found, that the largest potatoes yielded the largest crop ; and the same happened the third, when a few showed blossom ; but not even these had bulbs equal to what would have been produced by very large potatoes. Whence he concludes, that it is impossible to assign any time in which these seedling potatoes will arrive at what is called *perfection* ; but that it must depend very much on the nature of the soil and the culture bestowed on them. From the practice of the Yorkshire farmers, however, and even from the experiments of the Doctor himself, it is evident, that potatoes raised in this way will at last grow to the usual size, as during the three years in which his experiments were continued they constantly increased in bulk. Dr Anderson likewise contends, that there is no reason for supposing that potatoes raised from bulbs in the ordinary way degenerate, or require to be renewed by seminal varieties ; and he instances the universal practice of Britain and Ireland for a great number of years past. But this may be accounted for from an observation of Mr Marshal's, that varieties of potatoes, like those of corn, are partial to particular soils and situations. Hence, by transplanting all the different varieties of potatoes into all possible soils and

Culture of roots will be much
particular in particular
Plants. the second rise etc.

Another account from feed is given by Mr Chapel, Allerton, who says, that apples, when sown in a dry soil, when broken, were driven until some time after they had been sown, and then rarely produced their seed. Therefore, that there is a necessity of renewing them from seed; and it is to be considered whether it is eligible to choose the seed from a fleshy plant, or from that which is so far degenerated as to scarce produce its seed. "Potatoe varieties (says Mr Marshal) are a miscellany of varieties. Sometimes these varieties are very numerous; sometimes particular varieties are selected from seedling potatoes; and attention is to be attended to; the intrinsic quality, and its productiveness. If these properties can be found in one plant, the variety is continued. To this species of attention and care we are indebted for the many valuable kinds which are now distributed throughout the country. It is observable, however, that varieties of potatoe, and those of corn, are partial to particular soils and situations. Hence the propriety of husbandmen saving varieties from seed; as by this means they obtain a degree of moral certainty, a sort adapted to particular soils and situations. Whoever has applied himself to the work of taking up potatoes, must have observed the great inequality in the production of individual plants. The difference in the size of adjoining roots, where no disparity of situation, will sometimes be three or four fold."

Hence it is evident, that each variety has its *sub-varieties*; through whose means it can hardly be doubted ^{Culture of particular Plants.} the parent variety may be improved, and its continuance be prolonged. Thus the farmer has another mean in his power of improving the quality and productiveness of his potato crop, by improving varieties; or in other words, selecting sub-varieties, superiorly adapted to his soil and situation."

Sir Archibald Grant, Bart. of Monymusk, in a letter * to the conductors of the Farmer's Magazine, has recently made known a mode practised by him with a view to the saving of seed, and the obtaining an early crop of potatoes. "In spring 1800, (says that gentleman), from a scarcity of seed, I followed a method sometimes used by gardeners, for forcing early potatoes, pease and beans, viz. that of planting them out upon a small dunghill, in order to make them come sooner forward, and afterwards transplanting them into the ground. This I did, after they had upon the dunghill risen to be good plants, and the leaves about an inch long. The dunghill was about three feet broad and 18 inches high, with from 2 to 3 inches of earth upon the top of it, and as long as held about a peck and three quarters of a peck of Aberdeenshire measure (or 32lb. Dutch to the peck) of small potatoes, cut into sets, stuck as close to each other as possible in the rows, and each row about two inches asunder. On the 17th of April, they were put upon the dunghill; on the 2d of May they were in leaf; and on the 14th and 15th of May were planted out into the field; each plant 3 feet asunder each way. On the 12th June, they were earth-

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* *Farmer's Magazine*, June 1802.

Culture of ed up with the plough, and were afterwards dressed in particular Plants. the ordinary method. On the 1st Monday of October, being taken up, they produced from 14 to 16 bolls Aberdeen measure. In June I observed, that potatoes which had been planted in the ordinary way in other parts of the parish in the middle of April were scarcely appearing above ground when these were so high as to require being earthed up with the plough; so that six weeks were gained in growth by this method."

Potatoes planted by scooping out the eyes.

During the late great dearth of all kinds of provisions, a plan was adopted with a view to save for food a part of the potatoes used as seed, which consisted of not cutting them into pieces with one or more eyes in each piece, as usual, but of slightly scooping out the eyes, which in that state were planted while the greater part of the potato was preserved for the use of man or cattle. This mode of planting potatoes was successful with a great number of persons; but in some instances, where the ground was not in an excellent state of preparation, the crop is understood to have been more defective than when the usual mode was adopted of cutting off large pieces of the potato along with the eye. The point, however, about the utility of this mode of practice must still be considered as doubtful or worthy of farther investigation. We are rather disposed to think that the practice of slightly scooping out the eye will not ultimately prove beneficial, because in ordinary cases the plant will be left destitute of due nourishment from the parent root at too early a period of its growth, and before it is completely capable of deriving its subsistence from the soil around it; in the same manner, and for the same reason, that light seed is apt to produce a light crop of grain. This objection may not indeed

indeed hold good with regard to potatoes planted on a ^{Culture of} very fine soil, or upon a hot-bed, for transplanting after ^{particular} ^{Plants.} the manner adopted by Sir Archibald Grant above mentioned. But on poor lands, where the strength of the young plants is more severely tried, any defect in the size of the root planted will probably always be productive of bad effects.

2. TURNIP.

Turnip delights in a gravelly soil; and there it can ^{Culture of} be raised to the greatest perfection, and with the least ^{turnip.} hazard of miscarrying. At the same time, there is no soil but will bear turnip when well prepared.

No person ever deserved better of a country, than he who first cultivated turnip in the field. No plant is better fitted for the climate of Britain, no plant prospers better in the coldest part of it, and no plant contributes more to fertility. In a word, there has not for two centuries been introduced into Britain a more valuable improvement.

Of all roots, turnip requires the finest mould; and to that end, of all harrows frost is the best. In order to give access to frost, the land ought to be prepared by ribbing after harvest, as above directed in preparing land for barley. If the field be not subject to annuals, it may lie in that state till the end of May; otherwise, the weeds must be destroyed by a braking about the middle of April, and again in May, if weeds arise. The first week of June, plough the field with a shallow furrow. Lime it if requisite, and harrow the lime into the soil. Draw single furrows with intervals of three feet, and lay dung in the furrows. Cover the dung sufficiently, by going round it with the plough, and forming the three-feet spaces into ridges. The dung comes thus to lie below the crown of every ridge.

Culture of particular Plants. The season of sowing must be regulated by the time intended for feeding. Where intended for feeding in November, December, January, and February, the seed ought to be sown from the first to the 20th of June. Where the feeding is intended to be carried on to March, April, and May, the seed must not be sown till the end of July. Turnip sown earlier than above directed, flowers that very summer, and runs fast to seed; which renders it in a great measure unfit for food. If sown much latter, it does not apple, and there is no food but from the leaves.

Though by a drill plough the seed may be sown of any thickness; the safest way is to sow thick. Thin sowing is liable to many accidents, which are far from being counterbalanced by the expence that is saved in thinning. Thick sowing can bear the ravage of the black fly, and leave a sufficient crop behind. It is a protection against drought, gives the plants a rapid progress, and establishes them in the ground before it is necessary to thin them.

The sowing turnip broad-cast is almost universal in England, and common in Scotland, though improper in some respects. The eminent advantage of turnip is, that, besides a profitable crop, it makes a most complete fallow; and the latter cannot be obtained but by horse-hoeing. Upon that account, the sowing turnip in rows at three feet distance is recommended. Wider rows answer no profitable end, straiter rows afford not room for a horse to walk in. When the turnip is about four inches high, annual weeds will appear. Go round every interval with the slightest furrow possible, at the distance of two inches from each row, moving the earth from the rows towards the middle of the interval. A thin plate

of iron must be fixed on the left side of the plough, to prevent the earth from falling back and burying the turnip. Next, let women be employed to weed the rows with their fingers; which is better, and cheaper done, than with the hand-hoe. The hand-hoe, beside, is apt to disturb the roots of the turnip that are to stand, and to leave them open to drought, by removing the earth from them. The standing turnip are to be at the distance of twelve inches from each other: a greater distance makes them swell too much; a less distance affords them not sufficient room. A woman soon comes to be expert in finger-weeding. The following hint may be necessary to a learner. To secure the turnip that is to stand, let her cover it with the left hand; and with the right pull up the turnip on both sides. After thus freeing the standing turnip, she may safely use both hands. Let the field remain in this state till the appearance of new annuals make a second ploughing necessary; which must be in the same furrow with the former, but a little deeper. As in this ploughing the iron plate is to be removed, part of the loose earth will fall back on the roots of the plants; the rest will fill the middle of the interval, and bury every weed. When weeds begin again to appear, then is the time for a third ploughing in an opposite direction, which lays the earth to the roots of the plants. This ploughing may be about the middle of August; after which, weeds rise very faintly. If they do rise, another ploughing will clear the ground of them. Weeds that at this time rise in the row, may be cleared with a hand-hoe, which can do little mischief among plants distant twelve inches from each other. It is certain, however, that it may be done cheaper with the hand.

Culture of hand *Plants.* And after the leaves of turnips in a row meet together, the hand is the only instrument that can be applied for weeding.

In swampy ground, the surface of which is best reduced by paring and burning, the seed may be sown in rows with intervals of a foot. To save time, a drill-plough may be used that sows three or four rows at once. Hand-hoeing is proper for such ground; because the soil under the burnt *stratum* is commonly full of roots, which digest and rot better under ground than when brought to the surface by the plough. In the mean time, while these are digesting, the ashes will secure a good crop.

Properties of different sorts of turnip. In cultivating turnips to advantage, great care should be taken to procure a good, bright, nimble, and well-dried seed, and of the best kinds.

The Norfolk farmers generally raise the oval white, the large green-topped, and the red or purple-topped kinds, which from long experience they have found to be the most profitable.

The roots of the green-topped will grow to a large size, and continue good much longer than others. The red or purple-topped will also grow large, and continue good to the beginning of February; but the roots become hard and stringy sooner than the former.

The

* Children under thirteen may be employed to weed turnips with the fingers. We have seen them go on in that work with alacrity; and a small premium will have a good effect. For boys and girls above thirteen, a hand-hoe adapted to their size is an excellent instrument: it strengthens the arms amazingly. In driving the plough, the legs only are exercised; but as the arms are chiefly employed in husbandry, they ought to be prepared beforehand by gentle exercise.

The green-topped growing more above ground, is in more danger of sustaining injury from severe frosts than the red or purple, which are more than half covered by the soil ; but it is the softest and sweetest, when grown large, of any kind. We have seen them brought to table a foot in diameter, and equally good as garden turnips.

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Turnips delight in a light soil, consisting of sand and loam mixed ; for when the soil is rich and heavy, although the crop may be as great in weight, they will be rank, and run to flower earlier in spring.

From a statement given by the Agricultural Society of Penzance in Cornwall, it appears, that salt is there used with great success as a manure for turnips. “ The extensive pilchard fishery (say these gentlemen) *, established on our coasts fortunately enables us to make some use of this valuable manure. Salt is frequently imported for curing fish at 9d. or 9*½*d. per bushel of 84 pounds ; and what remains after it has been once or sometimes twice used in preserving the pilchards, is usually sold at about the same price to the neighbouring farmers. Unquestionably, some animal-oil is united to the salt ; but in the general opinion this is at least compensated by the admixture of fish scales, as that salt which has been least used is universally preferred, and found to be most effectual.

“ At Michaelmas 1790, Mr Sickler entered on an estate so much impoverished by the former tenant as scarcely to return the seed.

“ 1791.—In the spring of this year Mr Sickler prepared

* *Annals of Agriculture*, vol. xxvii.

Culture of ~~particular~~ ^{Plants} pared two acres for turnips which had borne seven crops of oats in succession. The last crop did not produce

nine bushels on an acre.

" In the first week of April, the earth from two ditches was carried into the fields and laid in four piles ; each pile received three cart-loads of sea-shell sand, and five bushels of salt. The earth from another ditch chiefly consisting of the decayed foil which had been taken off the ground in former tillage, was placed in three more piles ; and each of these received also three cart-loads of sand, but no salt, on account of the apparent richness of the earth. Half the field was manured with the four first piles ; but the three last not being sufficient for the other half, what remained was sown with salt at the rate of ten bushels to an acre.

" The part of the field where salt had been used, either mixed with earth or alone, produced about half a crop of turnips : but the crop totally failed where there was no salt. In the spring following, white oats were sown, and produced a crop of 45 bushels to an acre.

" 1792.—Three acres, which in 1791 had borne a crop of wheat, not exceeding 12 bushels on an acre, were ploughed before Christmas, and brought into fine tilth by midsummer following. On each acre were sown 20 bushels of salt, excepting that two ridges towards the middle of the field were purposely left without any manure : on these two ridges the turnips totally failed, but the remainder of the field produced a plentiful crop.

" 1793.—Four acres of land, completely worn out by successive tillages, were ploughed before Christmas ; three

three acres were sown with salt at the rate of 25 bushels, and the remaining acre with 18 bushels, without any other manure. The crop was in general a good one, but visibly best where the greatest quantity of salt had been used.

“Crops of turnips have been raised with equal success by the use of salt since that time, and in the severe winter of 1794-95, it was observed, that these turnips were much less injured by the frost than others similarly situated, and cultivated in the common way.

“When salt is used in the quantity of 20 or 25 bushels to an acre, the turnips should not be sown till at least three weeks after the salt. Clover sown with barley, after turnips raised by the use of salt, has never failed to produce an abundant crop of hay the year following.”

Turnip-seed, like that of grain, will not do well without frequent changing. The Norfolk seed is sent to most parts of the kingdom, and even to Ireland: but after two years it degenerates; so that those who wish to have turnips in perfection should procure it fresh every year from Norwich, and they will find their account in so doing. For from its known reputation, many of the London seedsmen sell, under that character, seed raised in the vicinity of the metropolis, which is much inferior in quality.

When the plants have got five leaves, they should be hoed, and set out at least six inches apart. A month afterward, or earlier if it be a wet season, a second hoeing should take place, and the plants be left at least 14 inches distant from each other, especially if intended for feeding cattle; for where the plants are left thicker, they

Culture of
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Plants.

Observa-
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Culture of ~~pared~~ two acres for turnips ~~w.~~
particulars ~~Plants~~ of oats in succession. The
~~—~~ nine bushels on an acre.

" In the first week ~~the~~ a second hoeing leave ~~the~~ ditches was carried into ~~the~~ piles ; each pile receiving sand, and five bushels ~~the~~ when sown in the com-ditch chiefly consisting ~~the~~ may easily be cleared of been taken off the ground in three more piles ~~the~~ before the Board of Agriculture three cart-loads of ~~the~~ interesting experiments, which apparent richness ~~the~~ were made by Mr W. Jobson manured with the ~~the~~ view to ascertain the comparative not being sufficient ~~the~~ of rearing turnips by drill or ed was sown with ~~the~~ was made upon a part of a field acre. ~~the~~ the month of June 1797. " The

" The part ~~the~~ Mr Jobson, was in equal tilth, was either mixed ~~as~~ as possible immediately before a crop of ~~the~~ mid-yard dung, at the rate of 17 there were ~~the~~ acre, each load containing about 28 were ~~the~~ and in order to make the experiment acre. ~~the~~ there were breadths of land of

" ~~the~~ ~~the~~ in broad-cast and drills alternate crop ~~the~~ the whole field. Part of the drills on were ~~the~~ of 27 inches each, with the dung laid tilth ~~the~~ underneath, where the row of seed was sown ~~the~~ rest of the drills upon a level surface, with ~~the~~ Mr Bailey's machine at 21 inches distance. ~~the~~ The produce per acre is calculated from the ~~the~~ a year square perches, or the fortieth part of

of each, having first cut off the tails, or Culture of
of the root, and thrown them aside as un- particular
and then taken the weight of the tops and Plants.
separately.

It is necessary to observe, that this field of turnip was a middling crop, having been much hurt immediately after the first hoeing, by the *grub* (a small insect which destroys the root), particularly the drilled part of the field, which, having had the plants set out, at the distances at which they were intended to remain before the grub seized them, was on that account rendered too thin and otherwise much injured; notwithstanding which, it was found that those on the one-about ridges exceeded the others in weight; also, that these parcels of turnips were taken from an inferior (though not the worst) part of the field, and may therefore be deemed to be a pretty fair average of the whole: there were also three other portions weighed, which were taken from a part of the field where the roots were larger, and a fuller crop, with a view to ascertain what might have been expected, had not the grub seized them in the manner described; but unfortunately the paper containing their weight has been lost or mislaid, which puts it out of my power to furnish you with it. There was also an account taken of the number (but not the weight) of loads which were produced upon a few acres of the worst part of the field which was in favour of the broad-cult, in the proportion of ten of broad-cast to nine of those drills on one-about ridges, and eight of Mr Bayley's drills.

" From this experiment (though defective from the reasons assigned) we have reason to conjecture, though not to form a conclusion, that a heavier crop may be

Culture of particular Plants. raised by sowing in drills at 27 inches distance with the dung immediately beneath the plants, than in broadcast or in drills at 21 inches on a level surface: but whether the advantage arises from the situation in which the dung is deposited, or from their having a freer circulation of air, or from both these united, it remains for future and repeated experiments to decide. Notwithstanding this, it will be found, that each of these methods possesses peculiar advantages and disadvantages, according to situations and circumstances; the reasons for which I deduce from the observations I have made respecting this as well as former crops. In the first place, the one-bout ridges I think preferable for early sowing, and eating off, through the winter months, even so late as the month of February, as they are more easily procured for food for cattle in deep snows; also in situations where it is difficult to procure a sufficient number of experienced hoers, those under the drill system can be more easily managed and at less expence, as boys and girls may be readily taught to set out the plants with great regularity in very little time; but turnips under this system are liable to the inconvenience of being more apt to be injured by severe frosts from their high exposure. Another inconvenience I have also observed on wet and heavy lands, more especially with little declivity, that although there should, and possibly may, be a larger crop produced thereby, yet the land will unavoidably be so much poached by carrying them off, that the succeeding crop of corn will be lessened more than the extra value of the turnips will compensate. When it is attempted to raise turnips upon land of this description, it will be found more advantageous to form it into ridges of sufficient

carry off the water with ease into the water Culture of
valves, and of sufficient breadth (suppose fifteen feet). particular
Draw a cart to pass along them freely, without for- Plants.
ming the earth in to choke up these furrows. The turnips
may be sown either in broad-cast or in drills, upon the
surface of these ridges. If the land is addicted to annual weeds, they will be best in drills, which will expedite the hoeing; but if not, or if they be late in sowing, or if the land be subject to the grub, broad-cast will generally be found to produce a more certain crop, as they can be left so near to each other at the first hoeing as to admit of being thinned, and thereby give the opportunity of taking out unhealthy plants at the subsequent hoeings, and also that they grow more vigorously between the first and second hoeings."

The result of the experiment here alluded to, is stated in the following manner:

COMPARATIVE

PRACTICE OF

COMPARATIVE WEIGHT of six portions of Turnips, which were part of a Field of fifteen Acres : the whole of which was Sown in the Month of June 1797, as an experiment between the Drill and Broad-cast systems.

	Time of weighing,	Number upan four square perches,	Weight on four square perches, or the 40th part of an acre.	Weight per statute acre.	Average weight of each turnip.	Average distance of each turnip.
		ROOTS.	TOPS.	Cwt. qr. lb. Gwt. qr. lb.	Tons cwt. qr. lb. Ibs. oz.	
Nº I. Drilled on one-bout ridges, at 27 inches distance.	January 354	8 1 1 1 3	19 1 0 20	3 0 20 3	0 16 1 16 1	in. by 27 in.
II. Drilled with Mr Bayley's machine, on a level fur- face, at 21 inches di- stance.	ditto.	428	7 1 1 5 1 1	1 5 1 1 7	1 8 2 4 1 7	in. by 21 in.
do.	do.	568	7 2 1 2 1 1	0 1 1 1 7	1 26 1 11 1 16 1	each way.
III. Broad-cast.	Mar. 2.	334	8 3 0 1 1 22	10 7 3 12 3	6 1 17 by 27 in.	
IV. Drilled on one-bout ridges, at 27 inches distance.						
V. Broad-cast. These and the preceding were round white turnips.	do.	628	8 2 2 2 1 1	9 20 0 2 24 1	12 1 16	each way.
VI. Broad-cast (Reduced).	do.	561	6 3 2 6 1 2 3	5 19 11 1 0	1 25 1 16 1	each way.

"By noting the average distance of each turnip, as is done in the last column, is intended to show, at one view, how many plants there were wanting in the drills to have made them a full crop; for, if 550 be stated as a medium number in a full crop, upon the 40th part of an acre, they will be found to occupy a space of 17 inches each way in broad-cast, $10\frac{1}{2}$ by 27 inches on the one-bout ridges, and $13\frac{1}{4}$ by 21 inches of those drilled on the level surface; from whence may be easily seen, how much those were wider in the rows than they ought to have been."

Dr Campbell of Lancaster, in his essay addressed to the Board of Agriculture, gives the preference in very decided terms to the cultivation of turnips in drills rather than broad-cast *. "On comparing the drill with the broad-cast system of cultivating turnips, I feel no hesitation in giving the drill system the preference; which opinion is gaining ground fast among my neighbours, who have had no opportunity of comparing the two methods. To say nothing of the superior, neat, and workman-like appearance which a field of drilled turnips exhibits in all its stages, there are many circumstances which contribute to give it a decided superiority over the broad-cast.

"The first is the security of the crop from the ravages of the fly. When dung is spread at random over a field, a part will receive a greater proportion of it than is necessary, and another a smaller. Should dry and hot weather come on immediately after the sowing, that dung, which is exposed to the influence of the sun,

* *Communications to the Board of Agriculture*, vol. iii.

Culture of particular Plants. will be dried up, and a great part of its juices and the volatile alkali which it contains will be exhaled and lost. The seeds that fall in the intervals betwixt the dung, or where there is a deficiency of it, will languish, and perhaps be cut off by the fly or snail, and at any rate will never attain a full size. In the case of the drill method the dung, being buried in the bottom of the furrows, is excluded from all evaporation, and the seed being deposited directly above the dung, is by the warmth which proceeds from it brought into immediate vegetation; and the young roots, as soon as the seed germinates, striking into the dung, occasion so rapid a growth, that in a few days the plants pass into the rough leaf, and get beyond the risk of injury from the fly, slug, or whatever vermin have a tendency to prey upon them in their weak state. It would appear, that the weak and sickly plants are particularly the objects of these destroyers, rather than the luxuriant and healthy. Vegetables, in a certain state of decay and of a yellow hue, are most sought after, and preyed upon by slugs in a garden; and I have taken notice, that some turnips from seeds accidentally dropt in the intervals of the drills, when there was no manure, have exhibited a sickly hue, and been preyed upon by some insects, whilst the vigorous plants in the drills escaped. In the course of the last three years that I have cultivated turnips in seasons where we have experienced the extremes of wet and drought on their coming out of the ground, I have not lost a single plant by the fly; which I am inclined to attribute to the rapid growth of the plants from the causes above enumerated.

“ Another advantage arises from their being able to stir and horse-hoe the land in the intervals of the drills;

by

by which means the weeds are more early and completely destroyed, at the same time that the ground is more effectually opened.

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"In land abounding with stones to the degree of some of ours, it appears, that it would be almost impracticable to hoe it properly, when sown in the broadcast way: in some situations it appears almost entirely a bed of stones, which would render the plants inaccessible to the hoe; whereas, by the drill method, it is easily effected.

"It appears, that in proportion to the deficiency of manure (either in quantity or quality) the drills should be brought closer together, and a smaller distance also be left betwixt the plants in hoeing them. It is quite absurd to leave the same space for a turnip, which we know will not attain the bulk of more than a few inches in circumference, as for another that will be two or three feet with the top in the same difference of proportion."

Great quantities of turnips are raised in Norfolk every year for feeding black cattle, which turn to great advantage.

It is well known, that an acre of land contains 4840 square yards, or 43,560 square feet. Suppose then, that food for every square foot contains one turnip, and that they weigh only two pounds each on an average; here will be a mass of food, excellent in kind, of 46 tons per acre, often worth from four to five guineas, and sometimes more.

Extraordinary crops of barley frequently succeed turnips, especially when fed off the land. In feeding them off, the cattle should not be suffered to run over too much of the ground at once, for in that case they

Culture of will tread down and spoil twice as many as they eat.
particular
Plants. In Norfolk, they are confined by hurdles to as much as is sufficient for them for one day. By this mode the crop is eaten clean, the soil is equally trodden, which, if light, is of much service, and equally manured by the cattle.

A notion prevails in many places, that mutton fattened with turnips is thereby rendered rank and ill tasted; but this is a vulgar error. The best mutton in Norfolk (and few counties have better) is all fed with turnips. It is by rank pastures and marshy lands, that rank mutton is produced.

If the land be wet and springy, the best method is to draw and carry off your turnips to some dry pasture; for the treading of the cattle will not only injure the crop, but render the land so stiff, that you must be at an additional expence in ploughing.

Method of To preserve turnips for late spring feed, the best method, and which has been tried with success by some preserving turnips. of the best English farmers, is, To stack them up in dry straw; a load of which is sufficient to preserve 40 tons of turnips. The method is easy, and is as follows:

After drawing your turnips in February, cut off the tops and tap roots (which may be given to sheep), and let them lie a few days in the field, as no weather will then hurt them.

Then, on a layer of straw next the ground, place a layer of turnips two feet thick; and then another layer of straw, and so on alternately, till you have brought the heap to a point. Care must be taken to turn up the edges of the layers of straw, to prevent the turnips from roiling out; cover the top well with long straw, and it will serve as a thatch for the whole.

In

In this method, as the straw imbibes the moisture exhaled from the roots, all vegetation will be prevented, and the turnips will be nearly as good in May as when first drawn from the field. If straw be scarce, old haulm or stubble will answer the same purpose.

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But to prevent this trouble and expence, perhaps farmers in all counties would find it most to their interest to adopt the method used by our neighbours the Norfolk farmers, which is, to continue sowing turnips to the latter end of August; by which means their late crops remain good in the field till the latter end of April, and often till the middle of May.

The advantages of having turnips good till the spring feed is generally ready, are so obvious, and so great, that many of the most intelligent farmers (although at first prejudiced against the practice) are now come into it, and find their account in so doing.

Turnips have long been in such general use as food for cattle, that the profit on raising them might be reasonably thought to be altogether certain; nevertheless, Mr Young, in the paper already quoted, informs us, that "turnips dunged for are universally a losing crop; for if they are staled from 30s. to 40s. an acre, their value does not amount to the dung alone which is spread for potatoes; yet the latter pays that dung, all other expences, and leaves a profit sometimes considerable. I admit that turnips fed upon the land will prepare better for corn; but that is by no means the question. Would not the dung raised in the farm-yard by the consumption of the potatoes, supposing it spread on the potato acre, make that produce more than the turnip one? I have no doubt but it would give a superiority. But turnips are liable to great failures,

Their culture said to be generally attended with no profit.

Culture of
particular
Plants.

Compared
with other
vegetables
as food for
cattle.

and cannot be relied on late in the spring : potatoes may ; and are applicable to uses to which the other root cannot be applied."—In the second volume of the Bath Papers, p. 101. we have a comparative account of the value of turnips, turnip-rooted cabbage, and lucerne, as food for cattle. The result of this writer's observations is, that "when sheep are allowed as many turnips as they can eat (which should always be the case when they are fattening), they will, on an average, eat near 20 pounds each in 24 hours. An acre of turnips twice hoed, will, if the land be good, produce about 50 tons ; which will, on the above calculation, maintain 100 sheep 52 days. The sheep mentioned weigh 20 pounds per quarter. An acre of turnip-rooted cabbage will maintain 100 sheep for a month, and sometimes five weeks ; but an acre of Scots cabbages will maintain 200 sheep a full month." The number fed by lucerne is not determined.

The fly occasions the great inconvenience in turnip culture.

The greatest disadvantage which attends a crop of turnips, is their being so ready to be damaged by the fly, which sometimes destroys them so completely, that they must be sown over again two or three times the same season, and even this without any certainty of success. Innumerable methods of avoiding this evil have been projected, several of which were formerly noticed; and we shall here introduce some additional remarks upon the subject. We have already stated Dr Campbell of Lancaster's proposal to drill with dung under the rows. The remaining remedies may all be reduced to the following classes : 1. Steeping the seed in certain liquids. 2. Fumigation of the fields with the smoke of certain herbs. 3. Rolling. 4. Strewwing foot, lime ashes, &c. on the surface of the ground. It is very difficult, however,

however, to determine, with any degree of certainty, whether remedies of this kind are effectual or not; because sometimes the turnips are not injured though no precaution has been made use of: and when this happens to be the case, after the use of any supposed preventive, the preservation of the crop is ascribed to the use of that preventive, whether it be really efficacious or not. The virtues of steeps seem to have been fully ascertained by Mr Winter Charlton near Bristol, of turnip seed whose experiments an account is given in the Transactions of the Society for Encouraging Arts, vol. v. The seeds were of the Dutch kind, sown on beds in the kitchen garden in drills, about twelve inches distant, an inch and a half deep, on the 11th of May 1786. The beds had been prepared with rotten dung in May 1785, and afterwards sown with cabbages. The quality of the turnips is exhibited in the following table; the best being marked 1; and those of inferior quality, 2, 3, &c. The observations were taken on the 26th of June.

Seed without any preparation,	-	-	-	1
steeped in train oil, flourished extremely.				
steeped in linseed oil, somewhat inferior,				1
Seed mixed with foot and water,	-	-	-	2
with drainings of a dunghill,	-			2
with elder and barton draining,	-			2
with foot,	-	-	-	3
with elder-leaf juice,	-	-	-	3
with elder and barton draining, foot being sowed over the covered drills,				3
with ditto, and lime sowed over the drills,	-	-	-	3
sowed with foot scattered over, and then covered,	-	-	-	3
	N n 4		Seed	

Culture of Seed sowed with barton draining, - - - 4
 particular Plants.
 an elder bush drawn over when the
 plants appeared, - - - 4
 with stale human urine, very few
 plants appeared.
 with flaked lime scattered over, and
 then covered, very few plants ap-
 peared,
 with elder, barton-draining, and flak-
 ed lime, very few plants appeared,
 with lime and barton-draining did not
 vegetate.

Another set of experiments was made with the green Norfolk turnip, drilled an inch and a half deep, the rows one foot distant, on beds eight feet three inches long, and two feet wide; half a drachm of seed allowed for each bed, steeped and mixed with various substances like the former. The seeds were drilled upon unmanured ground on the 20th of June 1786, and the observation made on the 17th of July. None of the beds were found free from the ravages of the fly; but the seeds which had been steeped in train oil and linseed oil were much more free from this injury than the others. The linseed oil, as in the former ex-periment, was found inferior to the train oil, which was supposed to have been owing to its being kept in a bottle that had formerly held oil of turpentine. The leaves of the steeped seeds were of a much darker green than the others, appeared twice as thick in bulk and luxuriancy, and the plants were considerably larger than those of the other kinds. The substances mixed with the rest were soopers ashes, wood ashes, pounded gunpowder, brimstone, flaked lime, foot, barton-drain-ing;

ing ; sometimes mixed together in various proportions, and sometimes with the addition of a portion of sifted mould.

These experiments show, that no dependence can be had on steepes or mixtures of any kind with the turnip-seed ; though the train oil and linseed oil seem greatly to have forwarded the vegetation of the plant. It does not appear that fumigation has ever been tried ; nor indeed does it seem easy to be tried in such a manner as might ensure success.—In the fourth volume of the Bath Papers, Mr Gullet of Devonshire gives such directions for performing the operation as he thinks would be productive of success.—In a preceding paper he had explained the good effects of fumigating orchards ; but the case with these must be very considerably different from a field of turnips. The trees in an orchard are elevated above the ground, and the smoke naturally ascends, and is blown along their tops : but in fumigating a large field of turnips, it must creep along the ground in such a manner as is by no means agreeable to its nature ; and without any excessive degree of labour, as well as a vast quantity of burning materials, there cannot be the least hope of success. Mr Gullet's directions are as follow : “ If the turnip-ground be spaded and burnt, or the weeds, &c. burnt without spading, the fumigation thereby may suffice to chase such of the winged tribe from thence as are then there ; but in all cases, when the field is ploughed and ready for sowing, let heaps be made at different places and intervals round by the hedges and boundaries of the turnip-ground, and some few scattered through the field ; then, as soon as the seed is sown, let the heaps on the windward side and the scattered ones be lighted and kept smothering during

Culture of particular Plants. ring the continuance of the wind in that quarter ; the less the fire, and the more the smoke, the better. Should the wind happen to shift, those heaps on the quarter it shifts to must then be lighted and kept smothering in like manner ; so that during the growth of the tender turnip leaf, and until it becomes rough and out of all danger, this fumigation and smoke, over and across the field, must be continued from one quarter to the other ; which I venture to assert, will effectually deter and prevent any winged insect tribe from approaching the turnip-ground : nay more, if there already, it would most completely drive them from thence, as such delicately formed insects (which can only feed on the most tender leaf) would be ill able to continue long in such a smother of fire and smoke. The consequence is obvious and certain, that if the fly be kept from approaching the field, the turnip-crop is safe ; and few, I believe, will disagree with me, that *prevention is better than remedy.*"

Our author does not say that he has ever tried this method with turnips ; but lays great stress upon his success in a similar experiment with cabbages, in order to preserve them from the caterpillar. To make the matter more sure, however, he recommends the trailing of a bush of elder over the turnip field at the time of harrowing or brushing in the seed : but this remedy has by numberless experiments been found insignificant, and by those above related seems even to be pernicious : so that whatever good effects we can expect from this method, must depend on the fumigation alone ; and even this is attended with very great uncertainties, as has already been observed.

Of rolling. Rolling promises to be of service when the young turnips

turnips are attacked by snails, which frequently destroy them; but it cannot be supposed to have much effect in destroying flies, these being too numerous and too minute to be effectually crushed by the roller: and indeed, though this has been frequently recommended, we have no decisive proofs of its having ever been attended with any good effect.

The strewing of foot, lime, ashes, &c. upon the ground, have been determined ineffectual by the experiments already related, at least when applied before the turnips come up; and there seems to be little hope of their proving more effectual even when applied after the crop has appeared above ground. We may argue indeed *a priori* about the taste or smell of foot, lime, &c. being disagreeable to insects; but of this, after all, we have no sufficient proof; and even though this were the case, the leaf foot emerges from under this covering, or the insects will feed on the under part of the leaves, where these substances cannot lie. It is evident, therefore, that very little can be expected from any of the methods hitherto proposed either by way of cure or prevention. The more probable methods are,

1. To sow the turnips at such a season of the year that they may be well grown before the fly makes its appearance. In the Bath Papers, vol. iv. p. 132. Mr Wimpey observes, that in order to procure food for their cattle in the spring before the grass is grown, farmers are obliged to postpone the sowing of turnips beyond the natural time of vegetation: but were turnips to be sown in April, as soon as the season would permit, it is very probable that there would be as great a crop of them as of other vegetables usually sown in these months. On account of the delay in sowing, however,

~~Culture of particular Plants~~ for the reason already mentioned, the success of the farmer becomes exceedingly precarious, unless he is so fortunate as to have a few rainy days, or cloudy weather and frequent showers, soon after the seed is sown: and this our author supposes to be the true reason why the turnip is a more uncertain article than any other. But though speculations of this kind have a great show of probability, there is not any experiment hitherto published, even by our author himself, by which the truth of the above conjecture can be absolutely ascertained. Our author, however, is of opinion, that none of the common methods proposed can answer any good purpose, farther than as by means of them the vegetation of the plant may be invigorated. Mr Wimpey recommends ashes, foot, or a rich compost of lime and dung, used in sufficient quantities; but the method of using them is, either to sow them with the seed, or rather by themselves immediately before, and to harrow them well in, that they may be completely incorporated with the soil. This for the most part would so invigorate and encourage the growth of the plants, as to be an overmatch for the most vigorous attacks of the fly.

Sowing a great quantity of seed. 2. Another method proposed for securing turnips from the fly, is by sowing such a quantity of seed as will be more than sufficient for the consumpt of the insects. This we find recommended in a letter to the Bath Society, by a gentleman-farmer in Essex, vol. ii. p. 238. His method is to make the land clean and fine as soon as the season will permit, and to sow four pints per acre. It may be objected, that if the fly does not take them, the plants will stand so thick, that they cannot easily be hoed; but this may be obviated by harrowing them first, which will make them fit for the hoe.

hoe. There can be no expectation of a crop if the fly takes them when only a pint of seed is sown per acre; but this gentleman remarks, that he has not in any one instance missed of a crop when he sowed four pints; because, though the fly has sometimes destroyed more than one half, and much damaged the other, still there was a sufficient number left behind. He also agrees with others of the Society's correspondents, that the ground should be well dunged and manured previous to the sowing of turnips, as this makes them grow vigorously, so that they quickly get into the rough leaf, in which state the fly will not touch them.

In the same volume, a gentleman of Norfolk remarks, that manuring the ground in autumn for turnips is preferable to the doing so in spring. This discovery he made in consequence of the following accident.—“A neighbouring farmer, not having a sufficient quantity of manure for all his turnip land, was under the necessity of sowing four acres unmanured. The effect was, that the turnips on the manured part of the land were mostly eaten off by the fly, while four acres unmanured escaped without injury.” In consequence of having observed this, the gentleman made a similar experiment, by manuring five acres well for turnips, and tilling three acres and a half in the usual way without any manure. The manured crops were almost all destroyed by the fly, so that he was obliged to sow most of the land over again. The three acres and a half which had no manure were entirely free from injury, though the plants were much smaller than those of the manured ground which came up. Not content with this trial, however, he repeated the experiment, by manuring six acres of wheat stubble in autumn, ploughing it

Culture of
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Manuring
in autumn
preferable
to spring
manure.

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~~Cultivate~~ ^{particular} ~~Plants~~ in immediately, and leaving it to incorporate with the earth during the winter : the turnips which grew upon this were as large as if the ground had been manured in the spring. This experiment was repeated with surprising success in two succeeding years ; whence he infers, that the fly is either engendered in the new dung or enticed by it. But when the manure is laid on in autumn it loses its noxious qualities, though it still retains its nutritive ones.—This conclusion, however, does not appear to be well founded ; for it is certain from undoubted experience, that turnips which have been well manured in the common way, have sometimes escaped any injury ; while others, which have got no manure at all, have been almost totally destroyed. Another material advantage, however, which this correspondent observes is to be derived from manuring in autumn is, that all the seeds contained in the manure, and which are of course carried to the land with it, vegetate almost immediately, and are mostly killed by the cold of the succeeding winter, while the few that remain can scarce escape destruction from the ploughshare.

^{Mr Wimpey's opinion of sowing a great quantity of feed.} Mr Wimpey is also of opinion, that it is proper to sow a large quantity of seed ; but thinks two pounds will be sufficient for an acre. A few ounces indeed would be sufficient to stock the land ; but as the article is so precarious, he thinks it by far the safest way to allow feed in plenty, and reduce the plants afterwards by harrowing. He observes also, that it is of great consequence to have feed both good in quality and of the best species. He prefers the large and green topped, as being the most sweet and juicy ; others give the preference to the red or purple-topped, as being harder.

hardier : but at any rate, the seed from the largest and finest transplanted turnips, of whatever sort, is greatly to be preferred, even though it should cost double or treble the price. Such as is sold by the seedsmen in London he found generally of a mixed kind, and often in great part not worth cultivating. "Whether plants from new or old seed are most secure from the degradations of the fly (says he), is perhaps a question which cannot be easily determined even by experiments ; for concomitant circumstances are frequently so much more operative and powerful, as to render the difference between them, if there be any, imperceptible. It is, however, known to every practical man, that new seed sprouts or vegetates several days before old ; and I think more vigorously : and it is equally well known, that the healthy and vigorous plants escape the fly, when the stunted and sickly seldom or never escape it. Hence it would seem, that new seed, *ceteris paribus*, is more secure from the fly than old ; and for my own use I would always prefer it."

3. The sowing of turnips along with grain.—
This, of all others, seems to be the most eligible and efficacious. In the second volume of Bath Papers, p. 210. a Hertfordshire correspondent gives an account of the success of an experiment of drilling turnips with wheat. A small field of spring-wheat was drilled in rows two feet apart ; and in the month of May turnips were sown by hand in the intervals. They came up very well, and were thinned once by the hoe. The crop of wheat turned out better than another field of the same soil sown broad-cult in autumn, though it ripened somewhat later. The turnips were no other way injured by cutting it, than having some

Culture of the large leaves trodden down by the reapers. After particular harvest the weeds were cut up round the turnips with Plants a hand-hoe, and they grew very large and vigorous. They were of the purple and white long kind; and the crop proved nearly as good as the same land produced in common. An excellent crop of barley and clover was got from the same field afterwards.

Mr Anderdon's experiments of sowing them with beans.

In the third volume of the same work we find an account of several successful experiments in sowing turnips between rows of beans. The advantages of this method are strongly set forth by R. P. Anderdon, Esq; who made some of the experiments, and are as follow:

“ 1. You may have a crop of beans and turnips on the same field the same year. 2. The bean crop being well horse-hoed, no ploughing is wanted for turnips, for which the best Norfolk farmers give five ploughings. 3. It is hoed cheaper, more effectually, and consequently more profitably, than in any other way. 4. The ground is kept clean from weeds. 5. It is in order for a Lent crop the succeeding year with one earth. 6. The ground is kept in heart, if not improved, by fallowing your alleys. 7. It brings the plant to perfection in poor ground, where it would not become so otherwise. 8. It doubles the crop in any ground which Mr Anderdon has had experience of. 9. You have the crops more within your own power in this than in any other method, let the seasons turn out as they will. 10. You may have on the same ground a bean and turnip crop annually, if the land be suitable, and you think proper. 11. The clay farmer, by this mode, renders land which is naturally unfit for turnips, so free and open by seasonable horse-hoeings, that it will bring this useful plant to great perfection.”

On this paper the Society made some remarks, and stated the following objections : 1. The same soil cannot be proper for both crops. Scotch cabbages are more adapted for a bean soil ; and they wished him to repeat the experiment with cabbages instead of turnips betwixt his beans. 2. The Norfolk farmers rarely use more than three ploughings for turnips, instead of five, as Mr Anderdon represents, unless the ground be full of couch-grass. 3. They think him too sanguine in his expectations of having double crops on the same field. 4. Nothing renders a clay soil so free and open as to have it exposed to frosts and snow by being laid up in high ridges in January and February ; but, on Mr Anderdon's plan, this cannot be done, unless the turnips are lessened in value by being fed off in autumn.

These strictures were sent to Mr Anderdon before the papers were printed, but did not make any alteration in his opinion ; and he replied to the following purpose :

1. *The same soil cannot be proper for beans and turnips,* &c.—Granted.—But had Mr Anderdon adhered rigorously to this rule, he would have sowed no turnips at all, not having on his farm any soil altogether proper for that crop ; “ but (says he) while I can get in single rows, four feet asunder or more, from half a dozen to half a score tons of turnips per acre, after, or rather between, a crop of beans in my heavy lands, I shall feel that product here more beneficial than to drop the mode.”

Mr Anderdon then proceeds to acquaint the committee, that he had tried the experiment as they wished with Scotch cabbages instead of turnips betwixt

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^{Culture of} the rows of beans; but the crop of the turnips was so particular ^{Plants.} much preferable, that he found himself inclined to suppose the cabbage would not get to so great perfection there as to be profitably introduced on a large scale, for want of the great quantity of dung necessary for that crop, and which could not be procured in that part of the country. He further remarks in favour of turnips, that they have an abundance of very small lateral fibrous roots, which run as far in search of food, and feed as ravenously where they can penetrate, as those of almost any other vegetable; and the plant certainly derives more nourishment from those than from its tap-root*.

2. *The Committee doubt of the possibility of doubling the crop.* Mr Anderdon gives the following explanation: "I have made many comparative trials on turnips between this mode and broad-cast sowing, and always found on *my ground* the horse-hoed crops the best. But here, in denoting the benefits of the horse-hoe by its *doubling* a crop, I wish to be understood, that if, *in soils like mine*, a crop be drilled, leaving proper intervals for horse-hoeing, and one part be horse-hoed, the other not, the horse-hoed part will double the other in product."

Mr Pa-
vier's opi-
nion.

This subject is further considered in the same volume by Mr Pavier, who viewed Mr Anderdon's turnips, and gave in a report of them to the committee. He supposes a crop of beans drilled in single rows at four feet distance, and the turnips drilled in the intervals,

* Here the Society remarks, that this is not the case with those kinds of turnips which grow chiefly above ground, and which are generally the best crops, and most capable of resisting the frosts.

vals, according to Mr Anderdon's method, there will then be four rows of 17 feet in length to make a square perch; whereas Mr Anderdon's rows were only 15 feet 8 inches in length; and this disparity in length will make a difference of weight on a perch from 230 to 249 pounds, and on an acre from 16 tons 8 cwt. 2 qrs. 8 lb. Mr Anderdon's produce, to 17 tons 15 cwt. 2 qrs. 24 lb.—Each turnip at this distance (viz. four feet from row to row, and nine inches in the rows) must occupy a space of three square feet; consequently the greatest number produced on an acre must be 14,520; but if sown in broad-cast, twice hoed, and the distance on an average 15 inches, each turnip will then occupy little more than one foot and an half, and the number produced on an acre may be about 27,920; an excess which may reasonably be supposed to overbalance the value of the beans, let us suppose the crop as great as we can reasonably do. Thus far the argument seems to lie against this method of cultivating beans and turnips together: but, on the other hand, Mr Pavier considers it probable that the expence of drilling and horse-hoeing the beans, together with drilling the turnips in the manner Mr Anderdon did, must be considerably less than that of fallowing and preparing the ground, and sowing the turnips in broad-cast; to which we must likewise add the facility of hoeing the drills in comparison of the broad-cast. But besides these, the great advantage arising from this method, and which, if certain, gives it a decided superiority, is, “the great chance, if not an almost certainty, of preserving the turnips from the depredations of the fly.” Mr Pavier was inclined to think that this must be the case, as Mr Anderdon had such crops repeatedly with-

Culture of out any damage of that kind : but the committee differ from him, and think that this must have proceeded from some other cause ; though they do not assign any reason for this opinion. "The principal point (says Mr Pavier), in determining this question, seems to me to be this : if the crop of beans drilled as above after deducting the seed, and some additional expence in taking the crop off the ground without injuring the turnips, can be, one year with another, supposed to be as valuable as the quantity of turnips that might be reasonably expected in the broad-cast method more than in the other, I should not hesitate to declare in favour of drilling between the beans."

Thus far the argument seems to be carried on *a priori*. Mr Wimpey, in the letter already quoted inclines to the practice of sowing turnips between beans planted in rows. "It exactly corresponds (says he) with all my observations on the successful vegetation of that root. A considerable degree of moisture is necessary to the rapid vegetation of that very juicy root, and nothing retains moisture equal to shade : and shade can be obtained and secured by no means so effectually on a large scale as in the intervals of tall growing plants, as beans or wheat planted in drills." The success of Mr Bult of Kingston, near Taunton, leaves little room to doubt of the propriety of the method, and its success in preventing the fly. The beans were planted in drills not quite two feet asunder, on two ploughings, horse-hoed three times, and the turnips sown in the intervals at the last-hoeing. The field measured six acres and a quarter, and was a very good clayey soil, but had not been manured, nor had any dressing laid upon it, for six years before. It produced

produced this year three quarters of beans per acre, Culture of particular Plants. and 37 tons 5 cwt. of turnips. This field was also viewed by Mr Pavier, who makes the following observations upon it. 1. The turnips were sown promiscuously among the beans at the last hoeing, which was given about midsummer; from which time nothing was done but drawing off the beans and carrying them off the land. 2. The crop of beans was believed to be considerably above 20 bushels per acre, which is much more than was produced by any other method that season in the neighbouring part of the country; and as Mr Pavier had this account before he saw the turnip crop, he did not expect any thing considerable from the latter; but as it turned out, the produce must be accounted highly profitable, when we consider that there was no crop lost, no preparation, dressing, nor any expence whatever, excepting the price of the seed and sowing it. 3. This he considers as one of the strongest recommendations of the drill husbandry he ever knew or heard of; but he is of opinion that it never can answer except where the ground is perfectly clean and free from weeds, by the crops having been horse-hoed for a few years before. 4. He thinks the beans ought to have been planted at wider intervals, by which the sun and air would be freely admitted, and the plants would also be less damaged by the operation of the hoe.

Mr Pavier likewise informs the Society of two other experiments on a similar plan; but with this difference, that the turnips were sown among the beans at the second horse-hoeing. The turnip crops were very good, on sowing turnips among beans. and the beans more than *double* the value of those raised in the usual mode of husbandry. "I think it is

Culture of very evident (says he), that the beans preserve the turnips from the fly; and as no expence or trouble attends the practice, I apprehend it will soon become more general." The Society own, that the uncommon success of Mr Bult's experiment *seems to militate* at least against what they said on Mr Anderdon's letter; but they insist that the cases are by no means similar. "Though the land (say they), in both instances, is called a *heavy clay*, they are very different. Mr Anderdon's is poor, wet, and cold: the other a good rich clay; and we apprehend naturally mixed with a kind of marl, which is called clay by persons not thoroughly acquainted with the nice distinction of soils apparently alike, but very different in their nature. Our principle therefore, that cold wet clay lands are unsuitable for turnips, remains unaffected by this experiment; and general practice confirms the truth of the theory."

In another letter, Mr Pavier gives a more particular account of the two other crops of beans and turnips raised upon Mr Bult's plan. The beans were drilled in rows about 22 inches distance, twice horse-hoed, and the produce from about 25 to 30 bushels the computed acre, or from 30 to 36 bushels the statute acre. The preceding summer had been very unfavourable to beans, and the produce per acre in the common husbandry did not, on an average, equal a third part of this quantity. One of these crops was superior to that of Mr Bult: they were sown upon a field of nine computed acres on the 10th of June, after the second horse-hoeing: but whether the second hoeing was performed too soon, the ground not clean, or whatever might be the cause, the beans were weeded twice by hand afterwards: and he is of opinion, that the turnips

were

were somewhat benefited by it. Mr Pavier was assured by a very intelligent farmer, that this was the best crop of turnips he had ever seen. The turnip-seed in the other crop was put in between the rows of beans by a hand drill; but the work was badly performed, the plants coming up in some places vastly too thick, and in others as much too thin; but wherever they happened to be of a proper thickness, the farmer told him it was one of the most profitable crops he ever had. The soil was wet, heavy, and not very favourable for turnips. Hence Mr Pavier deduces the following conclusions: 1. That with respect to beans in particular, the drilling and horse-hoeing is vastly superior to the common mode of husbandry. 2. That the beans are undoubtedly a good preservative of the turnips from the depredations of the fly. 3. That as by this method no crop is lost, and consequently no rent, but a mere trifle of expence (if any) chargeable to the turnip crop, it must be one of the most profitable as well as the most certain methods of propagating that useful root ever yet practised.—He still insists, however, that if he had an opportunity of trying this method, he would drill the beans in rows at a greater distance, that the turnips might be hand-hoed easily; and that he should prefer the London tick-bean to any other, by reason of their shortness and being such bearers; that he should also take off their tops as soon as the under blossoms began to decay; which, he supposes, would be of great service.

In this dissertation on the culture of turnips, we Instrument cannot avoid taking notice of an instrument used in Norfolk for transplanting them, and thus filling up the ^{for transplanting} gaps which frequently happen in fields from the failure

Culture of of the plants in particular spots *. It is represented in particular Plants. Plate XIII. fig. 4. and the construction and mode of using are obvious from the figure.—When the turnips are to be transplanted, the workman holds the long handle with the left hand, and the short one with the right hand drawn up. Put the instrument then over the plant that is to be taken up, and with your foot force it into the ground; then give it a twist round, and by drawing it gently up, the earth will adhere to the roots of the plant in a solid body; then with another instrument of the same size take the earth out where the plant is to be put, and bringing the instrument with the plant in it, put it into the hole which has been made by the other; then keep your right hand steady, and draw up your left, and the earth and plant will be left in the hole with the roots undisturbed. In this operation two men must be employed, each of them having an instrument of the form represented in the plate. One man takes up a plant, while the other fills his instrument with earth only, thereby making room for the deposition of the plant; so that the hole which is made by taking up the plant is filled with the earth taken out where the plant is to be put; which being deposited, he takes up a plant, and returns to the place he first set out from, the former man at the same time returning with the earth only; so that each man is alternately the planter, and each being employed both ways, the work goes on briskly.—This instrument was the invention of Mr Cubitt Gray of Southrepps, No. folk.

Turnip.

* *Bab. P. 247, vol. iv. p. 226.*

Turnips being the grand basis of the Norfolk husbandry, Mr Marhal gives a very particular account of their culture in that county.—The species cultivated are, 1. The common *white-flock*, called in many places the Norfolk turnip. 2. The *purple-flock* is similar to the former, but its rind is of a dark red or purple colour; its size in general smaller and its texture closer and firmer than that of the common white-flock; it also stands the winter better, and is more succulent in the spring, but it is not so well relished by cattle as the former; whence it is less generally cultivated. 3. The *pudding-flock*, the *tankard-turnip* of the midland counties, is in shape so perfectly different from the common sort, that it might be ranked as a distinct species. It rises in a cylindrical form, eight, ten, or twelve inches high, standing in a manner wholly above ground; generally taking a rough irregular outline, and a somewhat reclining posture. It very much resembles the common turnip, and is by much its most formidable rival. In many respects it seems to be superior, particularly in being readily drawn, and eaten off by sheep with much less waste than the common turnip.—The disadvantage is, that they are liable to the attacks of frost, by reason of their standing so high above the surface of the ground; so that on the whole, Mr Marhal concludes, that the common white turnip is to be preferred to every other.

In Norfolk, turnips are sown upon every species of arable land. Marl is found to be highly beneficial; and by means of this manure, a soil naturally unfit for turnips may be rendered proper for it. They succeed barley better than any other crop; some few are sown on wheat or pea stubble after harvest; but this is not

Culture of particular Plants. not a general practice. The manures in greatest reputation for turnips are dung, with a greater or smaller admixture of mould; *malt-coombs* are also in good repute, and oil-cake is used by a few individuals; "but it may be said that nine acres of ten of the turnips grown in east Norfolk are manured with muck."—The quantity of dung set on for a crop of turnips generally depends on the quantity on hand, and the quantity of turnip ground to be manured. From 10 to 15 cart loads of muck are considered as a good dressing; and about a ton of oil-cake to three acres; 50 or 60 bushels of malt-coombs, and 40 or 50 bushels of foot, to an acre.

Cultivation of turnips for early consumption. When turnips are intended for early consumption, the sooner they can be got into the ground the better; but when they are intended to stand the winter, the beginning of July is thought soon enough. The most general rule is to begin sowing about a week before midsummer, and continue till about a fortnight after, viz. from the 17th or 18th of June to the 7th

Method of sowing, and culture. or 8th of July.—Broad-cast sowing is universal, in the quantity of two pints to an acre. The seed is covered by two lines of a pair of light harrows drawn backward, in order to prevent the tines, which usually point something forward, from tearing up the clods, and burying the seed too deep. The horses are universally *walked* one way, and *trotted* back again in the same place. This is an excellent custom; the quick zig-zag motion of the harrows at once assisting to level the surface, and to distribute the seeds more evenly.—They are universally hoed; and unless they be sown very late, are generally hoed twice. The distance of time between the sowing and the first hoeing depends upon the soil and

and season ; the size of the plants being the only guide. When turnips are suffered to grow too large before they are hoed, the plants are difficult to be set out singly, and are liable to be drawn up by weeds, thereby acquiring a slender upright tendency ; whereas their natural growth, in their infant state, is procumbent, spreading their first leaves on the ground, and taking the form of a rose.—If the hoe be put in too soon, the plants which are set out are liable to be buried, and their tender roots disturbed in the act of setting out the neighbouring plants. The time for hoeing, as directed by the most judicious husbandmen, is when the plants, as they lie spread upon the ground, are about the size of the palm of the hand : if, however, seed-weeds be numerous and luxuriant, they ought to be checked before the turnips arrive at that size, lest being drawn up tall and slender they should acquire a weak and sickly habit. The proper distance depends upon the nature of the soil and the time of sowing ; such as are sown early, in a rich productive soil, require to be set out wider than those sown late on a soil of a contrary nature. If the soil be at par, the distance ought to be regulated by the time of sowing : if this be at par, the nature or state of the soil should be the regulator.—Mr Marshal complains of the conduct of the Norfolk farmers in general in this respect, who “ hack out their turnips 14, 15, or perhaps 18 inches asunder, without any regard to the state of the soil, or time of sowing. This practice was established while the Norfolk soil was full of marl, and new to turnips ; and when, it is probable, 11 or 12 inches in diameter was no uncommon size, with tops proportionally large and spreading ; and 14 or 15 inches might then be a proper distance.

Culture of But now, when the efficacy of marl is lessened, and particular Plants. the soil no longer the favourite of turnips, which seldom reach more than seven or eight inches in diameter, it is ruinous and absurd to continue the practice."

Cultivation of turnips for seed. Turnips are cultivated either for seed, for sale, or for consumption. When cultivated for seed, it is supposed in most parts of the kingdom that it ought always to be taken from transplanted roots; but in Norfolk they are frequently raised from such as are untransplanted. "It is a fact (says Mr Marshal) well understood by every husbandman in Norfolk, that if the seed be gathered repeatedly from untransplanted roots, the plants from this seed will become coarse-necked and foul-rooted; and the flesh of the root itself will become rigid and unpalatable. On the contrary, if it be gathered year after year from transplanted roots, the necks will become too fine, and the fibres too few; the entire plant acquiring a weak delicate habit, and the produce, though sweet, will be small. For the neck, or onset of the leaves, being reduced to the size of the finger (for instance), the number and size of the leaves will be reduced in proportion; and in a similar proportion will the number and size of the fibrils be reduced. From a parity of reasoning, it may perhaps be inferred; that when the neck acquires a thickness equal to that of the wrist, the size of the root will be in proportion.

With respect to the fibres or rootlings, this is a just inference; but with respect to the bulb, it is in a great measure erroneous. For a few generations the size of the bulb will keep pace with the increase of leaves and fibres; but after having once reached the limits

limits which nature has set to its magnitude, it begins to revert to its original state of wildness, from which to its present state it has undoubtedly been raised by transplantation. The farmer has therefore two extremes to avoid. The one is discoverable by the thickness and coarseness of the neck, the scaly roughness of the bulb, the thickness of the rind in general, the foulness of its bottom, and the forkedness of its main or tap root: the other by the slenderness of the neck, the fineness of the leaf, and the delicacy of the root. The former are unpalatable to cattle, and are therefore creative of waste: The latter are unproductive, are difficult to be drawn, and do not throw out such ample tops in the spring, as do those which are, by constitution or habit, in a middle state between these two extremes. There is not, however, any general rule respecting how many years turnips ought to be transplanted successively, and how often they ought to be suffered to run up from the seed-bed: the soil and situation have, and other circumstances may have, influence on the habit and constitution of vegetables as of animals; and the farmer must attend to the state of the turnips themselves. Whenever he judges, that, by repeated transplantation, they have passed the acme of perfection, then it is his duty and interest to let them run up to seed without transplantation. In Norfolk it has been found, by long experience, that transplanting two, three, or four years, and letting the plants run up the third, fourth, or fifth, will keep the stock in the desired state. The time of transplanting is from Old Christmas to Old Candlemas. In the choice of plants, the farmer is not guided by size, but picks the cleanest plants without regard to size; or,
more

Culture of more accurately speaking, he makes choice of such particular Plants. as are near, but not at or above, the state of perfection.

In almost every turnip-field there are plants in various states: much judgment, therefore, is requisite in the choice of plants. A piece of good ground near a habitation is generally chosen for this purpose; but the method of planting is various: the plants are generally set in rows, at uncertain distances from one another."

Method of planting. These distances the same author has observed to be 16 or 18 inches, and the distance of the plants in them nine or ten inches; but the practice of a man who, he tells us, is indisputably near the head of his profession, is to plant them in rows two feet asunder, the plants in the rows being contiguous. The only culture required, is to keep the intervals clean hoed; but when the seed begins to ripen, much care is requisite to keep it from birds. If the plot be large, it is necessary to employ a boy to scare them; but if it be small, and near the house,

Method of scaring away birds. Mr Marshal has known the following expedient used with success. "On a slender post, rising in the midst of the patch of seed, was fixed a bell; from which a line passed into the kitchen: in the most frequented part of this hung the pull. Whoever passed the pull rung the bell; so that in a farm-house kitchen, where a mistress and two or three maids were some of them almost always on the foot, an incessant peal was kept up; and the birds, having no respite from alarm, forsook their prey."

Of drawing the turnip. The time of drawing commences about Michaelmas, and continues until the plants be in blow. The process of drawing, he says, "in severe weather is an employment which nothing but custom could reconcile to those whose lot it is to go through it, namely, stout lads

lads and youths; whose hands are frequently swelled until the joints are discernible only by the dimples they form;" nevertheless he never heard of any instance of bad effects from this circumstance. When the tops will bear it, their method of pulling is very expeditious: they pull with both hands at once; and having filled each hand, they bring the two together with a smart blow to disengage the soil from the roots, and with the same motion throw them into the cart. If the tops be cut off by the frost, or if this be in the ground, the turnips are raised with two-tined forks named *crooms*. If the roots are buried under deep snow, it is removed by means of an implement called the *snow-sledge*. This consists of three deal-boards from one to two inches thick, 10 or 12 inches deep, and from seven to nine feet long, set upon their edges in the form of an equilateral triangle, and strongly united with nails or straps of iron at the angles; at one of which is fastened, by means of a double strap, a hook or an eye, to fasten the horses to. This being drawn over a piece of turnips covered with snow, forces up the latter into a ridge on each side, while between the ridges a stripe of turnips is left bare, without having received any material injury from the operation. Though it is customary, in drawing, to clear the ground entirely, our author met with one instance in which the small ones were left by a very good husbandman on the ground, both to increase in size, and to throw out tops in the spring; it being observable, that a small turnip sends up a top nearly equal to one whose bulb is larger. There is one inconvenience, however, arising from this practice: the plough is prevented from entering upon the soil until late in the spring; which

upon

Culture of upon some soils is an unsurmountable objection; particular Plants. though it may be very proper upon land which will bring good barley with one ploughing after turnips.

Mr Marshal relates the following simple method, by which a Norfolk farmer preserved turnips through a considerable part of the winter season. Having cut off their tops with a spade, he gave them to his cows, and carried the bulbs to a new-made ditch, into which he threw them, and then covered them up with straw, laying over it a quantity of bramble kids. Here they lay until wanted in a frost. They were then again carted by means of a fork, and given to the cattle, who ate them as well, or rather better than fresh drawn turnips; and in general they came out as fresh as they went in. Our author is of opinion, that this method might be extended to the preservation of turnips till the spring.



END OF VOLUME FIRST.

Plate I.

Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Model 3



Plate II.

Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.

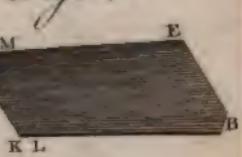


Fig. 5.



Fig. 7.

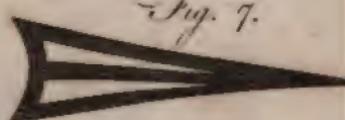
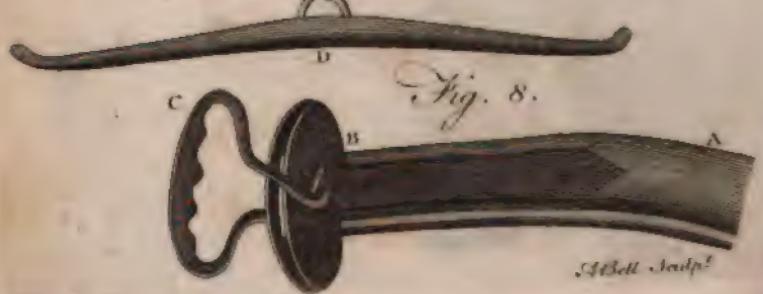


Fig. 6.



Fig. 8.



J. Bell Sculp^r

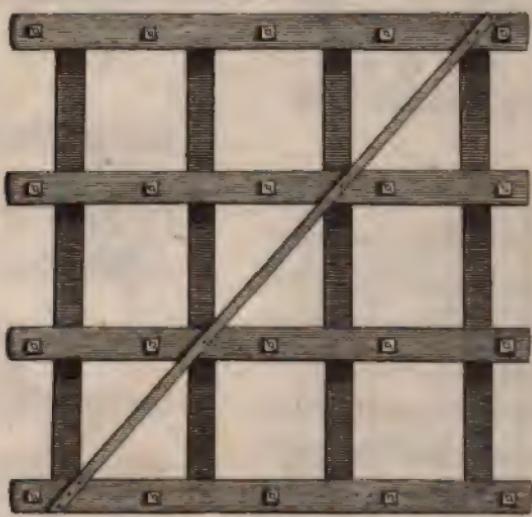


Plate III.

Fig. 1.



Fig. 2.



Collott Sculp't.



Fig. 1.

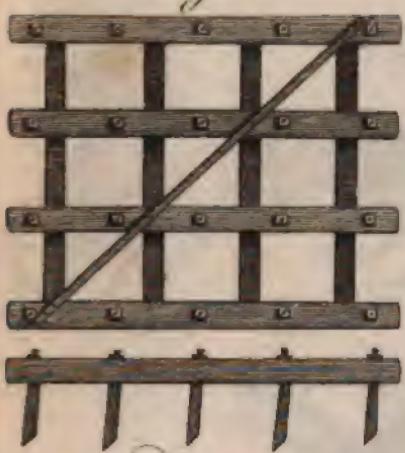


Fig. 3.



Fig. 5.

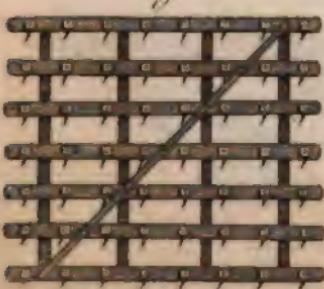


Plate IV.

Fig. 2.



Fig. 4.

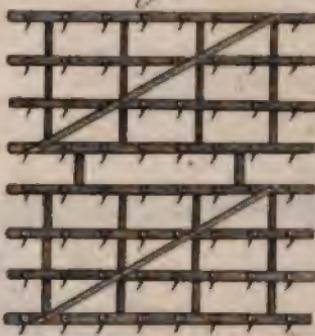
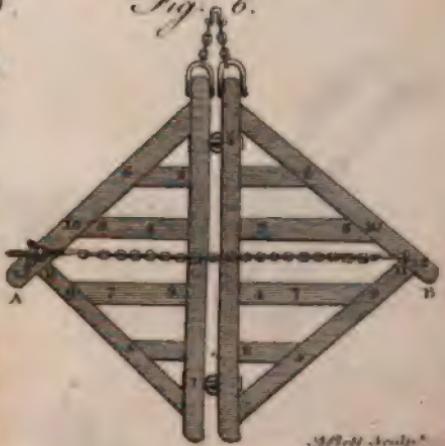


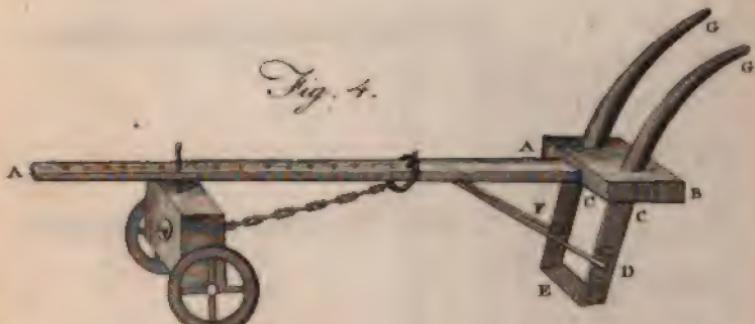
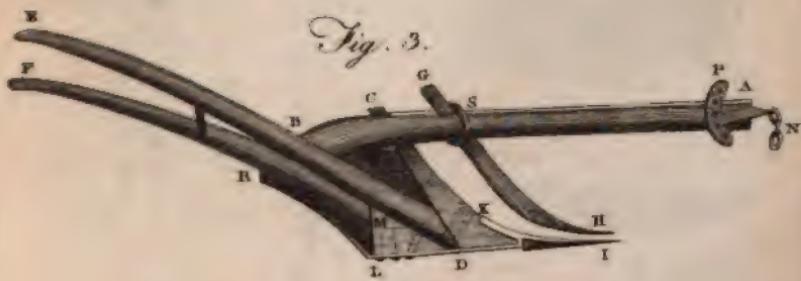
Fig. 6.



Aldis Sculp.



Plate V.



J. Bell. Sculp.



Plate VI.

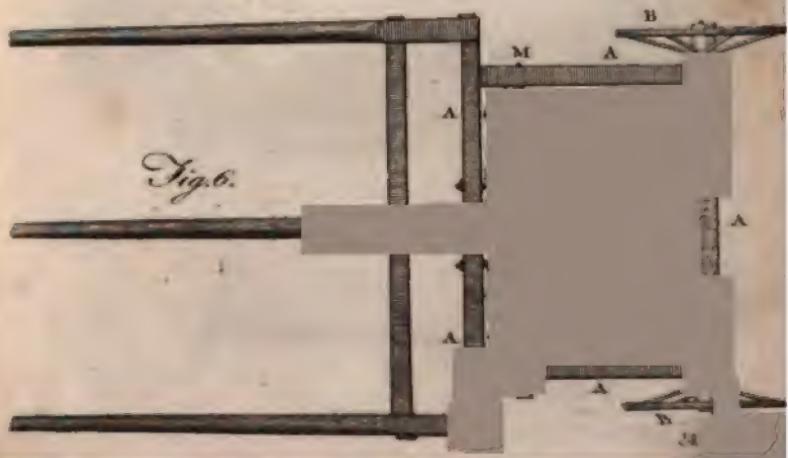
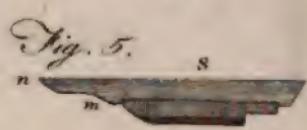
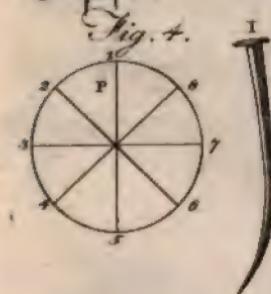
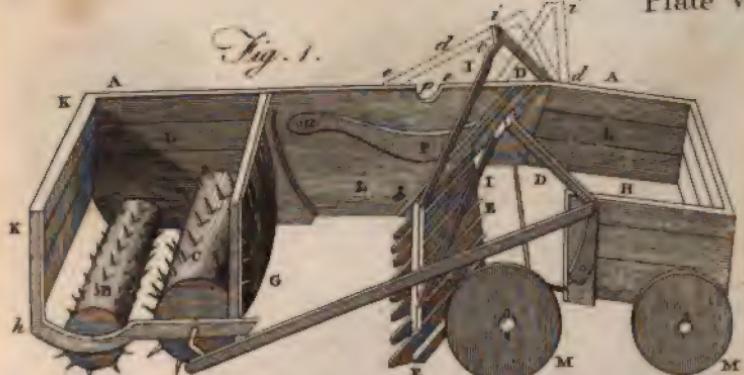




Plate VIII.

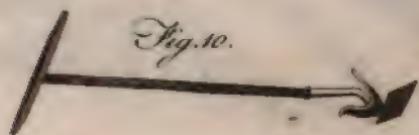
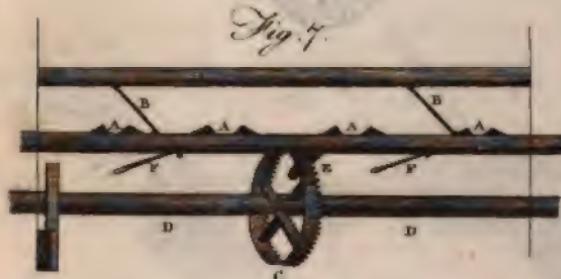
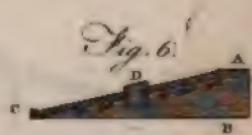




Plate IX.

Fig. 1.

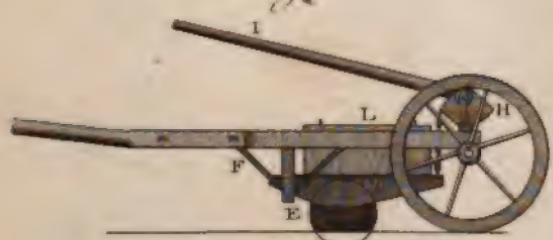


Fig. 2.



Fig. 3.



Fig. 4.





Plate XI

Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.





Plate XI.

Fig. 1.



Fig. 2.



Fig. 3.

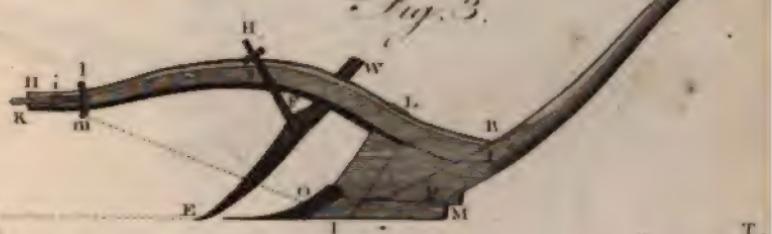


Fig. 4.

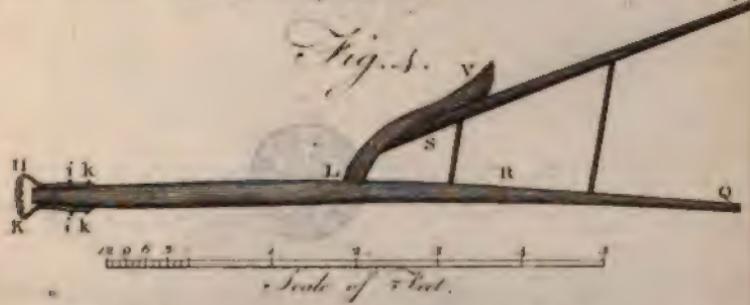


Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.





Plate XIII.

Fig. 1.

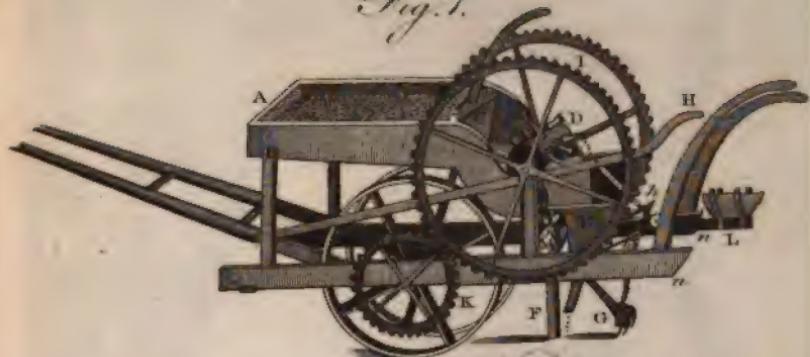


Fig. 2.

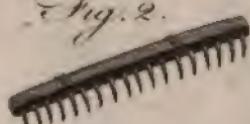


Fig. 3.

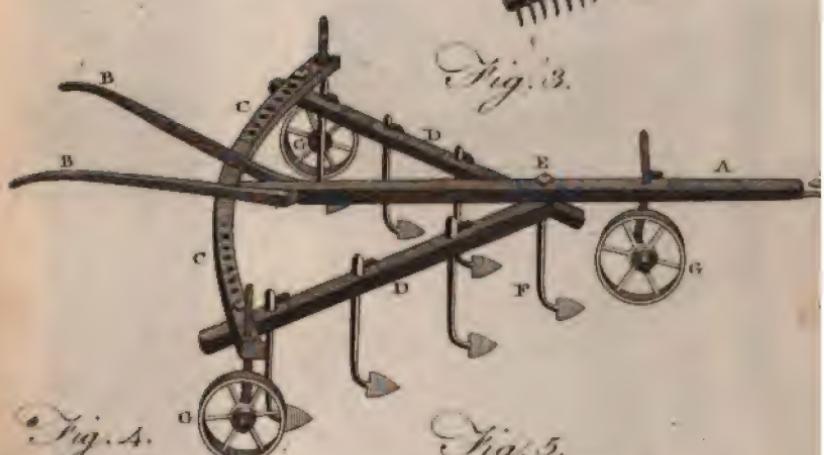
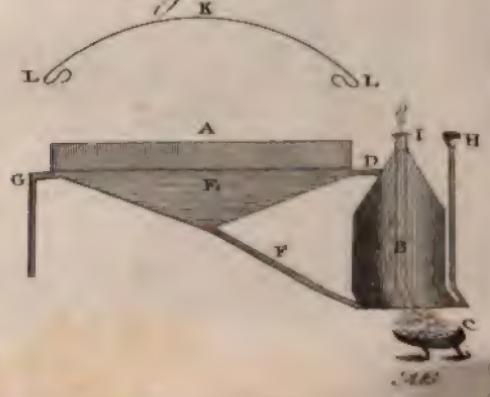


Fig. 4.



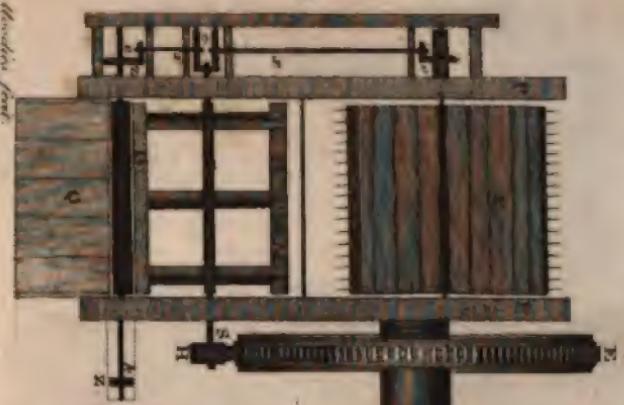
Fig. 5.



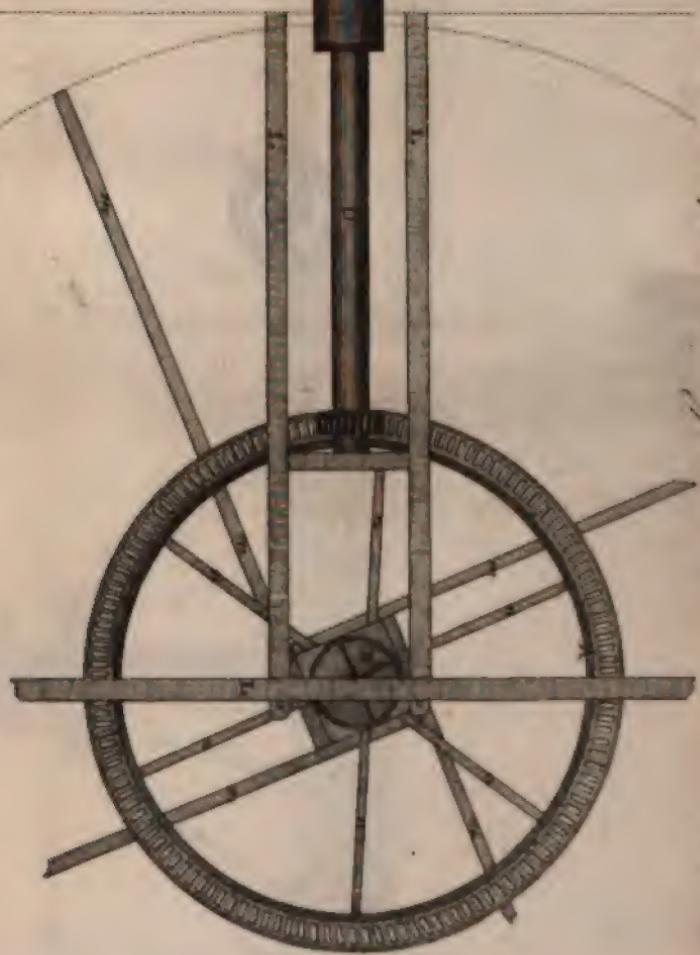


Mr. Ground's Plan of the Threshing Machine.

Plate XI



Front view.

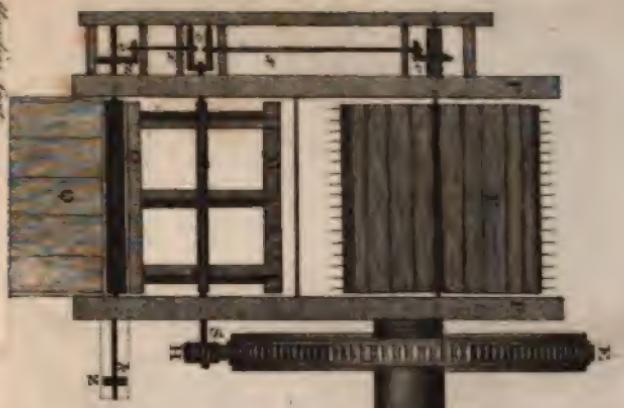


Side view.



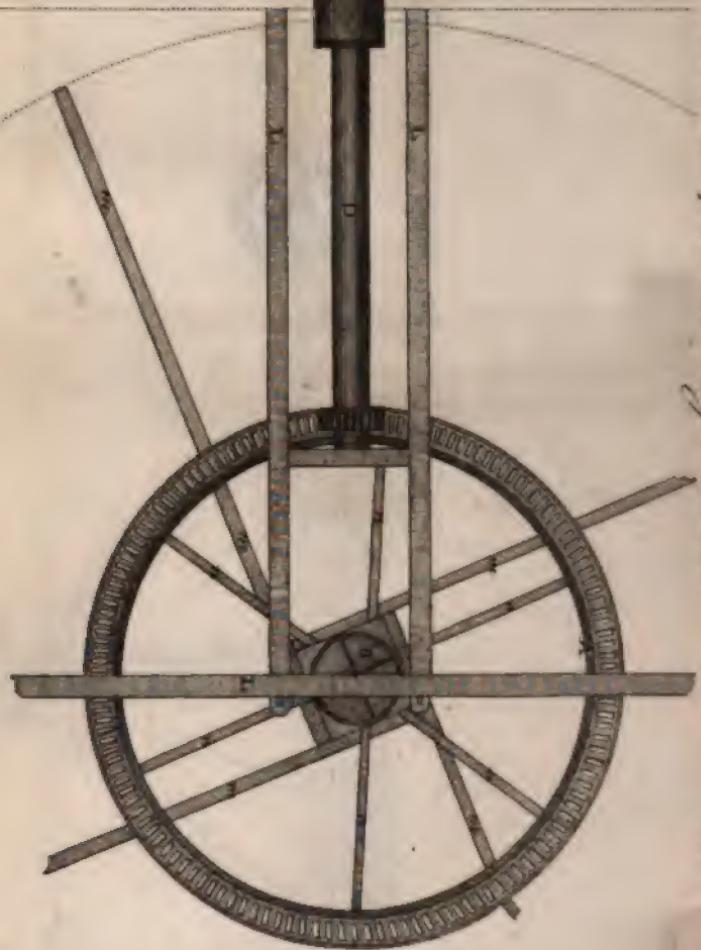
Aug. 1794. Plan of the Threshing-Machine.

Plate 5



Mendic. Soc.

1800. 1801.

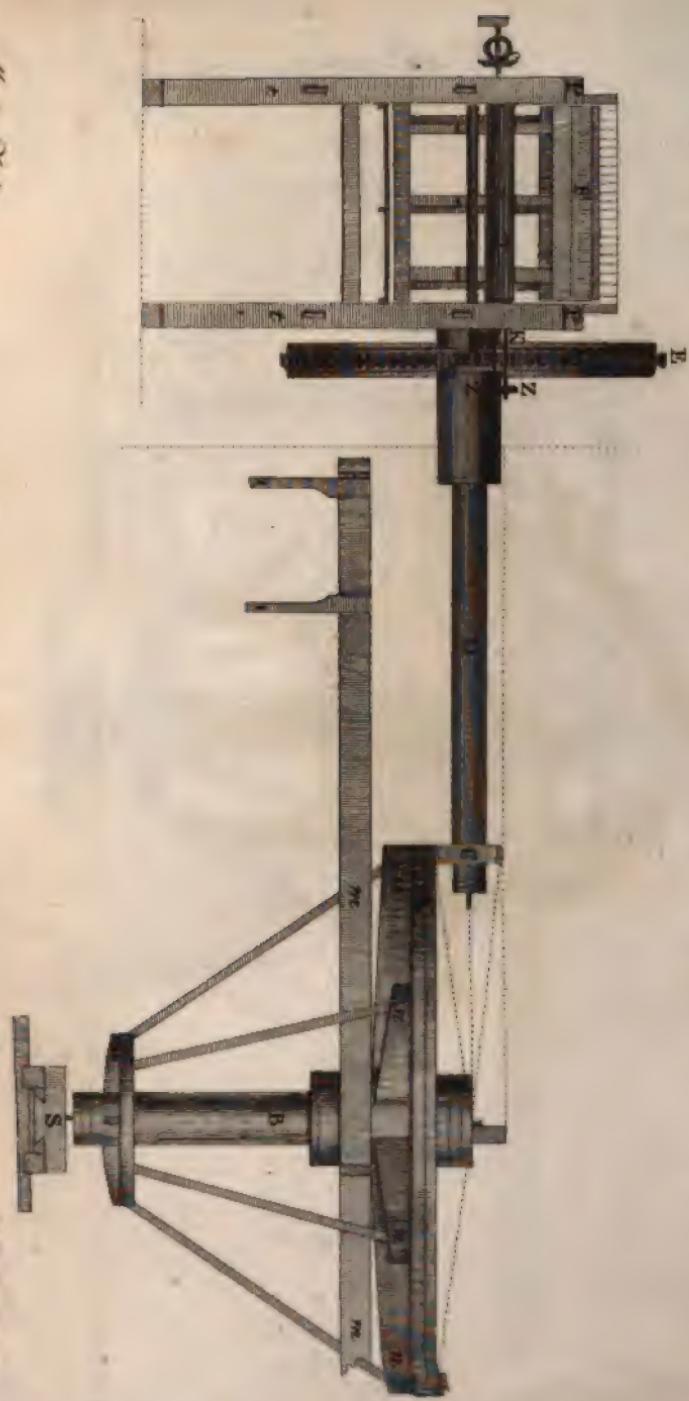




No. 2) Elevation of the Threading Machine.

Plate XVII.

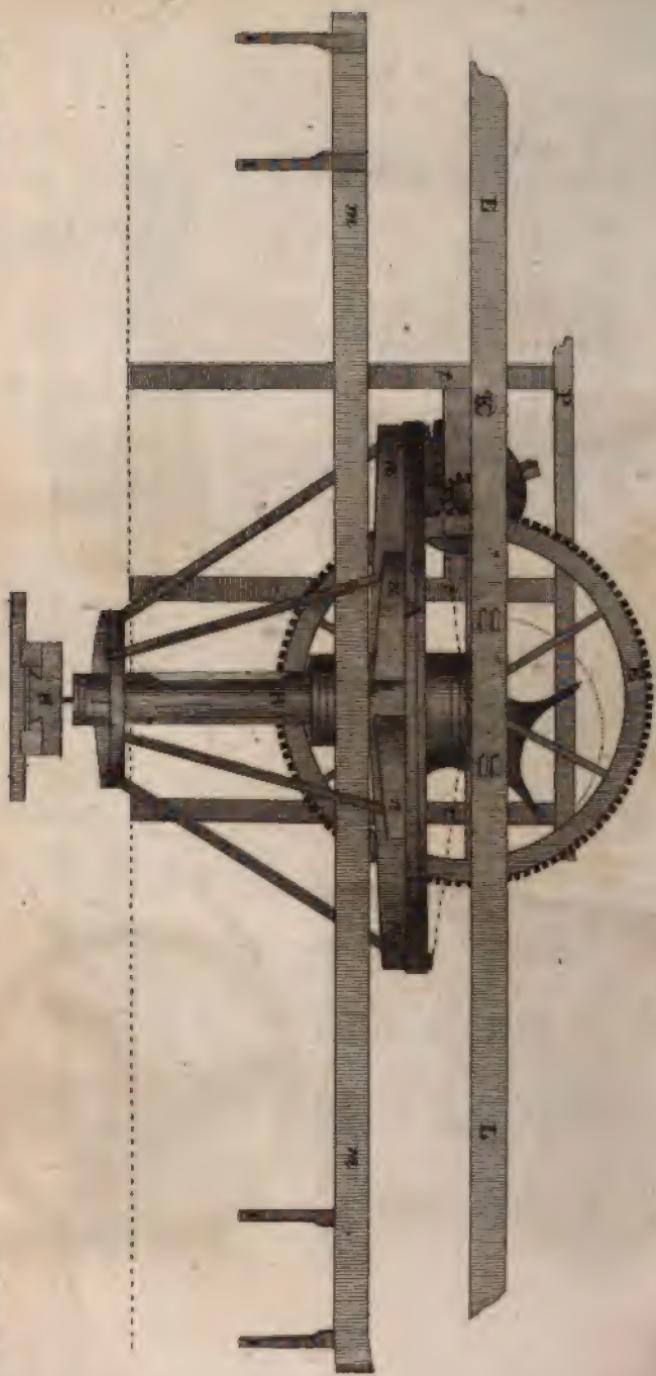
Woolmer's Patent.





No 3) End View of the Threshing Machine

Plate X



Mendes & Hart

Mill St.



Plate Xth.

Sketch of the Wheel for raising Water at Blair Drummond

How the Buckets empty themselves



Sketch of the manner in which the Water is filled from the Troughs into the Buckets



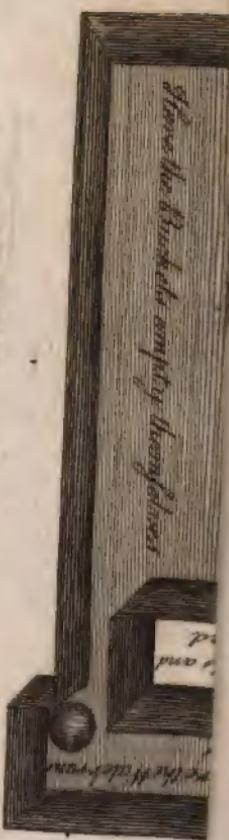
see p.



Plate XXI.

Sketch of the Wheel for raising Water at Blair Drummond

Show the Buckets empty themselves



Sketch of the manner in which the Water is filled from the Trough into the Buckets



Sketch





1

